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Part X

Department of Housing and Urban Development

Office of the Assistant Secretary for Policy Development and Research

Draft Rehabilitation Guidelines

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

Office of the Assistant Secretary for Policy Development and Research

[Docket No. N-79-957]

Draft Rehabilitation Guidelines

AGENCY: Department of Housing and Urban Development.

ACTION: Notice of Draft Rehabilitation Guidelines.

SUMMARY: HUD is inviting public comment on the draft rehabilitation guidelines developed for the voluntary adoption by States and communities to be used in conjunction with existing building codes by State and local officials in the inspection and approval of rehabilitated properties. Based on public comment received, HUD will revise the draft rehabilitation guidelines as required and publish the final rehabilitation guidelines not later than April 30, 1980. HUD is also seeking comment and recommendations on other areas where rehabilitation guidelines should be developed, areas where research should be undertaken and other comment and suggestions that would minimize the adverse impact of new construction oriented building codes on rehabilitation projects.

FOR FURTHER INFORMATION CONTACT: Robert J. Kapsch, Program Manager, Division of Energy, Building Technology and Standards, Room 8164, Department of Housing and Urban Development, Washington, D.C. 20410, Telephone (202) 755-8154.

DATE: Public comment on the draft rehabilitation guidelines are due by December 31, 1979. Comment should be submitted to Mr. Robert J. Kapsch, at the above address.

SUPPLEMENTARY INFORMATION: The rehabilitation guidelines were developed in response to Section 903 of the Housing and Community Development Amendments of 1978 (Pub. L. 95-557) which states: "The Secretary (of HUD) shall develop model rehabilitation guidelines for the voluntary adoption by States and communities to be used in conjunction with existing building codes by State and local officials in the inspection and approval of rehabilitated properties."

For a number of years it has been known that new-construction oriented building codes impact and impede rehabilitation projects. For example, in 1968 the National Commission on Urban Problems (the Douglas Commission) in its report to the Congress and the President recommended, "* * * that Congress authorize the Secretary of Housing and Urban Development to develop model standards to be incorporated in local building codes with special reference to the rehabilitation of existing housing." This recommendation was not acted on by the Congress.

In May 24, 1978, the Senate Committee on Banking, Housing and Urban Affairs (95th Congress, 2nd Session) received testimony from architects, trade associations, building officials and other interested parties to the effect that new construction oriented building codes impede rehabilitation projects in four ways: (1) they add additional, unnecessary project costs (estimated at 10 to 20% of total project costs), (2) they add unnecessary project approval times (in some reported cases), as much as 16 months over comparable new construction projects, (3) they discourage otherwise feasible rehabilitation projects, and (4) they produce an environment which permits and encourages payoffs of building officials.

As a result of this hearing, Senator William Proxmire, Chairman of the Senate Committee on Banking, Housing and Urban Affairs, introduced legislation which, with slight modifications by the Senate-House conferees, became Section 903 of the Housing and Community Development Amendments of 1978 (Pub. L. 95-557).

In his floor statement introducing this amendment, Senator Proxmire stated that, "The purpose of the guidelines is to encourage the rehabilitation and conservation of our older building stock. By making our existing housing stock safe, sound, and functional, we can very significantly aid in achieving our national housing goals, revitalizing our urban areas and reducing Federal expenditures." In introducing this amendment, Senator Proxmire made clear that the rehabilitation guidelines were not to be a Federal rehabilitation code. Said Senator Proxmire, "I do not believe that it is either necessary or desirable for Congress to mandate a Federal rehabilitation code. To do so would preempt the States' authority to regulate the safety and health aspects of buildings. Nor do I believe it desirable at this time to direct HUD to develop a new rehabilitation code. This would be a costly and time-consuming effort that would have little immediate impact." The draft rehabilitation guidelines are not a rehabilitation code but are intended to be used in conjunction with existing building codes.

The Department entered into a cooperative agreement with the National Institute of Building Sciences (NIBS) for the development of these guidelines. In executing this cooperative agreement, NIBS formed a Policy Steering Committee composed of representatives of various organizations of the building community. Those organizations represented, and the degree of their participation in the development of the rehabilitation guidelines, is detailed in the draft guidelines. In essence, it was the group that decided which of the 55 building code/rehabilitation problems identified should be addressed within the limitations of time and program budget.

The draft rehabilitation guidelines are divided into three volumes: (1) Administrative and Legal Guidelines for Building Rehabilitation, (2) Technical Guidelines for Residential Rehabilitation, (3) Fire Ratings of Archaic Materials and Assemblies. The first volume, Administrative and Legal, includes guidelines for setting and adopting standards for building rehabilitation, guidelines for municipal approval of building rehabilitation, statutory guidelines for building rehabilitation, and guidelines for managing official liability associated with building rehabilitation. An appendix is attached to these guidelines providing provisions adopted in States and municipalities relevant to rehabilitation. The Administrative and Legal Guidelines are intended for use by policy makers and other interested citizens in examining their building regulatory system with respect to the special needs of rehabilitation. The second volume, Technical, include guidelines for egress, for electrical installations and for plumbing drain, waste and venting. These guidelines are intended for architects, contractors, building officials and others who are having specific building code problems with rehabilitation project. The third volume, Fire Ratings, provides technical data no longer available in current regulatory documents. HUD is seeking public comment that would make the guidelines more effective. Comment received will be considered in the revision of these guidelines in final form.

HUD is also very interested in receiving from the public comment on what other actions, besides these guidelines, may be taken to minimize the impact of new construction oriented building codes on rehabilitation projects. HUD is seeking comment and recommendations on other areas where rehabilitation guidelines should be developed, areas where research should be undertaken and other comment and suggestions that would minimize

adverse regulatory impact on rehabilitation projects and yet maintain the safety and health that these buildings provide.

Public comment will be received by the Department until December 31, 1979.

Findings of inapplicability have been found with respect to the environment and regulatory analysis. Copies of these findings are on file in the Office of Regulation, Room 5218, Department of Housing and Urban Development.

Issued at Washington, D.C., October 26, 1979.

Donna E. Shalala,

Assistant Secretary, Policy Development and Research, Department of Housing and Urban Development.

[FR Doc. 79-33777 Filed 11-2-79; 8:45 am]

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Volume 1
Rehabilitation Guidelines

ADMINISTRATIVE AND LEGAL GUIDELINES FOR BUILDING REHABILITATION

FOREWORD

Section 903 of the Housing and Community Development Amendments of 1978 (Public Law 95-557, enacted October 31, 1978) requires that the Secretary of the Department of Housing and Urban Development:

> *"develop model rehabilitation guidelines for the voluntary adoption by States and communities to be used in conjunction with existing building codes by State and local officials in the inspection and approval of rehabilitated properties."*

Section 903 of the Amendments was predicated in part by the March 24, 1978 hearing on the "Impact of Building Codes on Housing Rehabilitation," held by the Senate Committee on Banking, Housing, and Urban Affairs. The hearing highlighted the many code-related problems that arise during the rehabilitation of the nation's existing building stock. Hearing testimony indicated that a significant cause of these problems was that existing codes and code enforcement techniques are primarily designed for new construction, and contain neither the administrative, legal, or technical mechanisms to properly deal with rehabilitation. This has led to:

- increased rehabilitation costs
- discouragement of otherwise feasible rehabilitation projects
- time delays due to lengthy municipal approval requirements
- encouragement of illegal activities by persons seeking to avoid unreasonable code requirements

Section 903 of the Amendments also requires that the Secretary of the Department of Housing and Urban Development shall:

> *"publish such guidelines for public comment not later than one year after the enactment of this section, and promulgate them no later than eighteen months after such date of enactment."*

Accordingly, the following draft documents have been prepared for public comment:

Rehabilitation Guidelines, Volume 1
Administrative and Legal Guidelines for Building Rehabilitation

Rehabilitation Guidelines, Volume 2
Technical Guidelines for Residential Rehabilitation

Rehabilitation Guidelines, Volume 3
Guideline on Fire Ratings of Archaic Materials and Assemblies

The intent of these guidelines is to reduce, while maintaining essential levels of health and safety, those regulatory requirements that create unnecessary constraints, time delays, and higher costs for building rehabilitation.

Volume 1, Administrative and Legal Guidelines for Building Rehabilitation, is designed for use by building officials, members of the legislative and executive branches of State and local governments, and related commissions and organizations that are involved in developing or implementing building regulations. Volume 1 covers the following topics:

- The Guideline for Setting and Adopting Standards for Building Rehabilitation provides an introduction and background to the building regulations that affect rehabilitation. It shows methods for identifying existing regulatory conditions in a community and lists recommendations for amending or modifying the community's regulatory system to encourage rehabilitation.
- The Guideline for Municipal Approval of Building Rehabilitation outlines a model submittal, review, and approval process for rehabilitation that is recommended for adoption by municipal building departments.
- The Statutory Guideline for Building Rehabilitation provides recommendations for statutorily modifying existing code decision making systems with the express goal of promoting rehabilitation.
- The Guideline for Managing Official Liability Associated with Building Rehabilitation addresses the liability of code officials involved with the regulation and enforcement of building rehabilitation, and provides recommendations for minimizing liability problems.

Volume 2, Technical Guidelines for Residential Rehabilitation, is intended for use by code inspectors, designers, and builders involved in residential rehabilitation. Volume 2 covers the following topics:

- The Egress Guideline for Residential Rehabilitation lists design alternatives for the components of egress that are regulated by current codes: number of exits, corridors and stairs, arrangement of exits, travel distance, dead-end travel, and exit capacity and width.
- The Electrical Guideline for Residential Rehabilitation discusses the establishment of standards for electrical rehabilitation, gives procedures for conducting inspections of electrical systems, and presents problems and solutions associated with electrical rehabilitation.
- The Plumbing DWV Guideline for Residential Rehabilitation includes a background discussion of basic drainage and hydraulic concepts, followed by criteria to determine the condition and capacity of

existing DWV (drainage, waste, and vent) systems. Methods and criteria are presented for relocating fixtures, adding new fixtures to existing DWV systems, extending existing DWV systems, and installing new DWV systems in existing buildings. Through-the-wall venting is also discussed.

Volume 3, Fire Ratings of Archaic Materials and Assemblies, is intended for use by code officials and designers in determining the fire ratings of building materials and assemblies that are no longer listed in current building codes or related reference standards. Extensive entries are provided for the fire ratings of walls, columns, floors and ceilings. Introductory material discusses flame spread, the effects of penetrations, and methods for determining the ratings of assemblies not listed in the guideline.

The draft rehabilitation guidelines were prepared by the National Institute of Building Sciences under contract to the Department of Housing and Urban Development. Issues addressed in the guidelines were selected from a March, 1978 study by the Institute entitled "Code-Related Rehabilitation Problems: Problem Identification/Verification/Feasibility Report," which identified approximately fifty code-related problems and determined that eighteen of these problems were feasible to address within the state-of-the-arts and within the legislated time constraints. Actual problem selection was made by a committee formed by the Institute under the legislative mandate that:

> *"such guidelines shall be developed in consultation with.....appropriate national organizations of agencies and officials of State and local governments, representatives of the building industry, and consumer groups, and other interested parties."*

The committee formed by the Institute was composed of representatives of the following organizations:

- Council of American Building Officials
- National Conference of States on Building Codes and Standards
- National Fire Protection Association
- American Institute of Architects
- Building Code Action
- National Home Improvement Council
- National Housing Rehabilitation Association
- National Association of Home Builders
- AFL-CIO Building and Construction Trades Department
- Association of Major City Building Officials
- U.S. Conference of Mayors
- National League of Cities
- National Trust for Historic Preservation
- U.S. League of Savings Associations
- National Association of Housing and Redevelopment Officials

Major subcontractors used by the Institute for addressing the selectec problems included:

- Building Technology, Inc.
- Joseph Stein
- Davidson Laboratory, Stevens Institute of Technology
- Council of American Building Officials
- J. Bradford Corporation
- National Fire Protection Association
- Arthur D. Little, Inc.
- National Conference of States on Building Codes and Standards
- Vincent Brannigan, Esq.

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CHAPTER 1

GUIDELINE FOR SETTING AND ADOPTING STANDARDS

FOR

BUILDING REHABILITATION

PART I

INTRODUCTION AND BACKGROUND

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PURPOSE OF THE GUIDELINES AND INTENDED USERS

PURPOSE

This guideline is intended to serve the following purposes:

(1) To present a method for describing and analyzing the existint regulatory system affecting all buildings (existing and new) in a community. This method includes identification of all pertinent codes and regulations, as well as all departments involved in their enforcement.

(2) To present a method for assessing the impact of standards set by the existing regulatory system on building rehabilitation in the community, and for identifying problems and constraints for rehabilitation.

(3) To recommend methods for amending or modifying the existing regulatory system so as to establish and enforce standards which encourage rehabilitation.

INTENDED USERS

The following groups or individuals may use this Guideline:

(1) Citizen groups (voluntary or appointed) who wish to assess the impact of the building regulatory system on rehabilitation in their community.

(2) Policymakers in city government (mayor, council, city manager, community development director, etc.) who wish to assess the impact of the existing building regulatory system on rehabilitation, and/or to amend or modify it in order to encourage rehabilitation.

(3) Code enforcement department heads (building officials) who wish to assess the need for amendment or modification of the existing building regulatory system in order to encourage rehabilitation.

INTRODUCTION TO THE REGULATION OF BUILDING REHABILITATION: STATE-OF-THE-ART

A. BUILDING REGULATIONS

In order to adapt or modify a jurisdiction's existing building regulatory system so as to promote rehabilitation, particular residential rehabilitation, or in order to minimize the constraints which that system may impose on rehabilitation projects, it is first necessary to understand the building regulatory system in general terms and how that system regulates existing buildings.

A.1 HOW THE BUILDING CONSTRUCTION AND MAINTENANCE REGULATORY SYSTEM REGULATES EXISTING BUILDINGS

Communities or other jurisdictions (e.g., states) currently regulate new and existing buildings by one or more of the following five types of regulations:

- Hazard abatement codes
- Past building codes
- Retroactive laws and regulations

(1) Construction Codes

Construction codes are generally referred to as "Building Codes". Actually they include a building code (regulating structural, fire, accident and health safety aspects of buildings), electrical code, a plumbing code, a mechanical code and a variety of specialty codes such as a boiler code, and an elevator code.

The objective of these codes is to provide certain levels of safety, health, welfare and property protection for building occupants and for the general public. To accomplish this they regulate design, construction, repairs, use, maintenance, moving, and demolition of buildings, or portions thereof.

Building codes often provide two approaches to compliance: prescriptive and performance. The relevance of this distinction to rehabilitation will be discussed later. Codes prescribe acceptable materials, sizes and methods for construction. However, most

modern building codes also provide a performance approach by providing for the acceptance of alternate materials and methods of construction. The following sections of the Uniform Building Code (UBC), Standard Building Code (SBC), Basic Building Code (BBC) and National Building Code (NBC) define this approach:

UNIFORM BUILDING CODE - 1979 Edition

"Alternate Materials and Methods of Construction

"Sec. 105. The provisions of this code are not intended to prevent the use of any material or method of construction not specifically prescribed by this code, provided any alternate has been approved and its use authorized by the building official.

"The building official may approve any such alternate, provided he finds that the proposed design is satisfactory and complies with the provisions of this code and that the material, method or work offered is, for the purpose intended, at least equivalent of that prescribed in this code in suitability, strength, effectiveness, fire resistance, durability, safety and sanitation.

"The building official shall require that sufficient evidence or proof be submitted to substantiate any claims that may be made regarding its use. The details of any action granting approval of an alternate shall be recorded and entered in the files of the code enforcement agency."

STANDARD BUILDING CODE - 1979 Edition

"103.6 Alternate Materials and Alternate Methods of Construction

"The provisions of this code are not intended to prevent the use of any material, or method of construction not specifically prescribed by this code, provided any such alternate has been approved and its use authorized by the Building Official. The Building Official shall approve any such alternate, provided he finds that the proposed design is satisfactory and complies with the provisions of Chapter XII, and that the material, method of work offered is, for the purpose intended, at least the equivalent of that prescribed in the code of quality, strength, effectiveness, fire-resistance, durability, and safety. The Building Official shall require that sufficient evidence or proof be submitted to substantiate any claim that may be made regarding its use. If, in the opinion of the Building Official, the evidence and proof are not sufficient to justify approval, the applicant may refer the entire matter to the Board of Adjustments and Appeals as stipulated in Section 111."

THE BOCA BASIC BUILDING CODE - 1978

"109.4 Alternate Materials and Equipment:

"The provisions of this code are not intended to prevent the use of any material or method of construction not specifically prescribed by this code, provided any such alternate has been approved. The building official may approve any such alternate provided he finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method of work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire-resistance, durability and safety."

NATIONAL BUILDING CODE - 1976

"100.7 Materials and Methods of Construction

"Nothing in this Code shall be construed to prevent the use of any material or method of construction whether or not specifically provided for in this Code, if upon presentation of plans, methods of analysis, test data or other necessary information, to the building official by the interested person or persons, the building official is satisfied that the proposed material or method of construction complies with specific provisions of or conforms to the intent of this Code."

Such provisions provide local officials with a significant potential for flexibility, which can be used to encourage building conservation, rehabilitation and reuse, or to

reduce constraints thereto, when existing buildings cannot easily comply with the prescriptive requirements of the codes. Traditionally, however, the "alternate materials and methods" approach has been used for approval of new products where the basis for acceptance is reasonably clear. It has been used to a much lesser degree for the acceptance of alternate design methods for meeting the intent of the code which is often the problem in building rehabilitation. There are two reasons for this: First, there is no general agreement on what is covered by the terms "materials and methods of construction." For example, some interpret these to include dimensions specified in the code (e.g., stair widths), while others consider such specifications as "design specifications" to be excluded from "materials and methods." Second, the codes lack a clear "code intent statement" of the several building attributes regulated (e.g., structural safety, fire safety, accident safety, health and hygiene.

Building codes often give the enforcement official authority to modify code provisions in individual instances, when practical difficulties in full compliance are involved. While this modification authority provides the official with opportunity to exercise judgement, it is too exceptional to be considered as a general vehicle for the encouragement of building conservation, rehabilitation and reuse.

Construction codes may be adopted at the state or the local leval, depending on state law. The various specialty codes (building, electrical, plumbing, etc.) may be enforced by one agency or by various agencies of government. These options may have significant impact on building regulation in general, and on building conservation, rehabilitation and reuse in particular.

The enforcement of provisions of construction codes is usually triggered by an application for a permit (building, electrical, plumbing) to construct.

Construction codes are periodically updated. The model codes, which are adopted by many jurisdictions, are updated and republished every three years, with amendments published periodically between each new edition. The updating of codes involves four types of code modification:

- Elimination of references to materials and methods of construction no longer used in modern construction (i. e., "archaic" materials and methods).
- Addition of reference to new materials and methods of construction.
- Addition of new requirements.
- Modification of administrative provisions.

It is often stated that, in general, the updating of codes represents a constant increase in the specified levels of safety, health, welfare and property protection. While this statement is in need of proof, it is clear that building codes change periodically in response to changing technology, new materials and products, and the changing needs of building occupants and the community at large, and that a building constructed to a past building code is not likely to meet all provisions of the current code.

Building codes regulate building rehabilitation and reuse in several ways, which are discussed in Section B. of this part.

(2) Property Maintenance/Housing/Health Codes

The basis for adopting property maintenance codes is contained in the building codes. The three model building codes, and nearly all other modern building codes, contain sections which require that all buildings, both existing and new, be maintained in a safe and sanitary condition.

It is apparent that building codes requiring maintenance and repair allow repairs to be made in a manner consistent with the original construction system. Where materials are no longer available (wood lath for example) a modern-day counterpart can be used.

Maintenance essentially means that the structural, fire, and health and safety features of a building be maintained at levels comparable to those existing at the time the building was constructed.

Communities may regulate existing buildings by means of property maintenance codes. Most widely used of these are housing (or health) codes. Housing codes have traditionally been used for establishing minimum

levels of health in existing residential occupancies (one and two family dwellings, apartments and hotels). Property maintenance codes contain the requirements of the housing code plus requirements applicable to other occupancies. Housing codes contain many specific requirements, while property maintenance codes tend to be more performance based (containing general statements of objectives).

Fire prevention codes are also a form of property maintenance code. They are intended to control the fire hazards in buildings by proper operation and maintenance procedures.

Housing codes and fire prevention codes are adopted either by the state of local government. They are often enforced by a different agency from that charged with enforcing the building code. The enforcement of these codes is usually triggered by complaints and by routine periodic inspections (the latter often concentrating on selected occupancies or selected neighborhoods). In some communities, the enforcement of these codes may also be triggered by periodic license or permit requirements (e. g., business license, fire marshal's permit, etc.) It is likely that in many communities there is a significant number of buildings which do not comply with the housing and/or fire prevention codes, due to the limitations on resources available for routine inspection of all buildings. Often, housing code enforcement is done by persons with special sensitivity to the needs of residents--a feature which may be of potential benefit for the encouragement of building conservation, rehabilitation and reuse.

General property maintenance codes are most often adopted by local government, since they are applicable to any occupancy. However, their adoption is not widespread.

Housing codes and property maintenance codes cover many of the same aspects of buildings addressed in new construction codes. For these same aspects, however, they usually establish levels of health, safety and welfare which are lower than the respective levels established by the new construction codes. The actual levels established by the maintenance codes are not usually stated explicitly, due to the general language of these codes.

The enforcement of housing and property maintenance codes often became the basis for mandatory repairs (see Section B below) in existing buildings. However, by providing a baseline level of health and safety for existing residential and/or other buildings, these codes may be employed to encourage building conservation, rehabilitation and reuse.

(3) Hazard Abatement Codes

Codes for the Abatement of Dangerous Buildings, or similarly titled documents, provide a basis for measuring or evaluating the condition of an existbuilding. These codes very carefully provide for due process ensuring that the enforcing body acts legally when it deems a building to be dangerous and requires its repair, evacuation, or demolition.

The International Conference of Building Officials (IBCO) and the Southern Building Code Congress International (SBCCI) each publish a code for the Abatement of Dangerous Buildings.

Building Officials and Code Administrators International (BOCA) includes similar provisions within the Basic Building Code.

These codes include fairly easily implemented provisions for structural analysis, and give specific limits for material stresses. The requirements for the fire safety, accident and health generally refer back to the code under which the building was built, and address how the required building safety elements are currently operating and are maintained. These requirements are stated in general performance language.

Hazard abatement codes have traditionally been used as the means to secure demolition of buildings. Their enforcement is usually triggered by complaints, inspections or any other actions which bring the potential hazard to the attention of the authorities.

These codes establish levels of safety and health which are lower than those established in building codes for new construction. It may be implied that these levels are also lower than those of property maintenance codes.

Implied in all building regulations, and in hazard abatement codes, is the concept of "imminent hazard." This is the absolute lowest level a building can reach. The discovery of an "imminent hazard" in a

building will justify drastic enforcement without permitting any delay in correction. While not specifically defined in the codes, a guideline for determining "imminent hazard" is included in Part III of this Guideline.

(4) Past Building Codes

As discussed earlier, the implication contained in all building codes and property maintenance codes is that the minimum requirement for an existing building is that the building, and any required safety equipment and devices, be maintained to the level required by the code under which the building had been constructed. As discussed earlier, these past codes establish levels of health, safety, welfare and property protection which are different from, and are usually lower than, those of current new construction codes.

(5) Retroactive Laws/Regulations

In some cases States or local governments have declared certain building features unsafe, or otherwise undesirable, and have required that all buildings of a certain occupancy or class be altered to remove the unsafe or undesirable condition, or to install some specific feature making the building appropriately safe or desirable.

Examples of such retroactive regulations are:

- High-Rise Requirements Adopted by the California State Fire Marshal (Appendix 1).
- City of Los Angeles Stairway Enclosure Requirements for Hotels, Apartments and Similar Residential Buildings Exceeding Two Stories in Height (Appendix 2).
- City of Los Angeles Preliminary Draft of "Earthquake Hazard Reduction in Existing Buildings," currently being considered for adoption (Appendix 3). This draft deals potentially with all building occupancies, reclassifying them into four hazard classifications.
- Appendix Chapter 12 of the 1979 Uniform Building Code, "Existing Buildings" (Appendix 4). This chapter is applicable to existing nonconforming Group R. Division 1 occupancies (hotels, apartment houses, convents and monasteries) more than two stories in height.

In all cases, existing buildings covered by the retroactive regulations are required to be modified to conform to the new minimum provisions. The levels of health, safety, welfare and/or property protection required by such retroactive regulations may be the same as, or lower than, the respective levels required by codes for new construction.

The enforcement of a retroactive regulation is triggered by inspections called for by the regulations itself. Often the enforcement is constrained by the community's available resources, in which case the community may establish a schedule for enforcement based on neighborhood location, type of building or other factors.

A. 2 CONTINUED USE AND OCCUPANCY--BUILDING CODES AND EXISTING BUILDINGS

Building codes traditionally permit the continued use and occupancy of buildings in existence at the time of the adoption of the code. This is often referred to as the "non-conforming rights" of existing buildings. Section 104(c) of the 1979 edition of the Uniform Building Code is a case in point:

> *"Buildings in existence at the time of the adoption of this code may have their existing use or occupancy continued, if such use or occupancy was legal at the time of the adoption of this code, provided such continued use is not dangerous to life."*

A similar section contained in the 1978 edition of the Basic Building Code reads as follows:

> *"The legal use and occupancy of any structure existing on _____(date of adoption of this code) or for which it has been heretofore approved, may be continued without change, except as may be specifically covered in this code and the housing code or as may be deemed necessary by the building official for the general safety and welfare of the occupants and the public."*

Similar code sections occur in other modern building codes used throughout the United States. Accordingly, in order to mandate that an existing building be repaired or brought up to some minimum condition of safety, one of three possibilities exists:

- establish that a building is dangerous in accordance with a hazard abatement code or similar regulation;
- enforce a property maintenance code; or
- enforce a retroactive law or provision.

A.3 LEVELS OF HEALTH, SAFETY, WELFARE AND PROPERTY PROTECTION

The preceding discussion has alluded to the various levels of health, safety, welfare and property protection implied by the various codes and regulations being discussed--with new construction codes defining the highest, and hazard abatement codes defining the lowest. It may be useful for communities considering setting or adopting standards for building rehabilitation to formalize this concept of levels of performance required by the various codes and regulations.

For each major objective of codes--health, safety, welfare, and property protection--one can conceive of a scale of performance. New construction code requirements may be thought of as defining the upper limits of such a scale; hazard abatement codes may be thought of as defining the lower limits of such a scale (with "imminent hazards" being specific points below or at the lower limit). Property maintenance codes and past building codes may be viewed as occupying given points between those limits. This concept is shown in diagram 1 ~~(next page)~~.

An existing building may be thought of as embodying levels of health, safety, welfare and property protection anywhere between these limits or above the upper limit. Retroactive laws and regulations may mandate the upgrading of such a building to some specified level (with regard to a specific code objective or attribute). However, when such a building is rehabilitated, the existing set of regulations, as discussed earlier, will explicitly or implicitly require that building to reach a specified new level. The following section of this Part (Section B) discusses how this new level of performance is currently specified by building regulations.

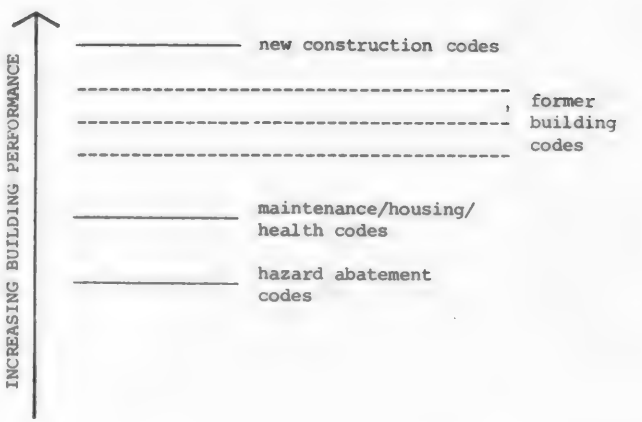

Diagram 1. Conceptual Diagram of Various Levels of Building Performance Imposed by Various Types of Building Regulations

While this concept of "levels' may be useful in considering building rehabilitation, it should be kept in mind that it may not be possible to actually quantify or measure a given level, or the difference between levels (e. g., egress potential of current codes and older codes).

Finally, for every level which is specified by a set of code requirements, the "alternative materials and methods" provision of modern building codes (as discussed earlier) recognizes that a given level can be achieved by alternatives to compliance with the code requirements. Such alternatives achieve equivalent performance. It is essential to make a clear distinction between equivalent performance (achieved by alternative means) and reduced performance.

B. IMPLICATION OF CURRENT REGULATIONS FOR BUILDING REHABILITATION

B.1 CURRENT REGULATIONS AND BUILDING REHABILITATION

In general, building codes address building rehabilitation in two categories:

- Maintenance, alteration and repair of existing buildings not involving a change of use or a change of occupancy.
- Change of use or occupancy in existing buildings.

(1) No Change of Use or Occupancy (25-50% Rule)

Rehabilitation work involving no change of use or occupancy can be qualified into two distinct categories:

- Voluntary maintenance, alterations or repairs (modernization, upgrading, etc.).
- Mandatory maintenance, alterations or repairs.

Voluntary repairs or maintenance of a building and its facilities involves work which is to conform to the code under which the building was initially constructed. The idea and action are voluntary. Rehabilitation work in this category is in general included in the building's non-conforming rights under the building code, although it may trigger a host of violations considered hazardous which are unrelated to the voluntary work. It may also trigger degrees of compliance with new construction codes through the 25-50% Rule to be discussed below. Whatever requirements are imposed, their enforcement is triggered, in this case, by an application for a construction permit (building, electrical, plumbing, etc.).

Mandatory repair or maintenance results in a building and its facilities being required to conform to a level of safety as defined by law (codes for the abatement of dangerous buildings, property maintenance codes, housing codes, and/or specific retroactive provisions). The applicant may be given a period of time to comply. The idea and action are mandatory. Rehabilitation work in this category may trigger degrees of compliance with new construction codes through the 25-50% Rule.

Commonly, building codes control rehabilitation with no change of use by means of the 25-50% Rule.

According to research done by the National Conference of States on Building Codes and Standards (NCSBCS), the 25-50% Rule first appeared in building codes as part of provisions dealing with fire districts and was applied to buildings which were non-conforming within the fire district. As population and usage density increased in urban areas and several fire disasters occurred, communities became increasingly aware of the danger of fire literally consuming whole areas of a city where many buildings were of wood frame construction. The criterion of 50% of value was used to require demolition, or replacement of frame exterior walls with conforming construction. In other words, the original purpose of the rule was to prevent rehabilitation of certain classes of buildings.

The actual wording of the 25-50% Rule in the four model codes is contained in the following sections:

- Basic Building Code, Section 106.0
- Standard Building Code, Section 101.4
- Uniform Building Code, Section 104
- National Building Code, Section 104.3

In the 1979 edition of UBC, Section 104 has been revised to drop all references to cost of rehabilitation. For the purposes of the following discussion, reference to the UBC version will be to the 1976 edition, since many jurisdictions are still using this edition. There are certain similarities and differences among the four versions which should be noted.

a. Over 50%

The BOCA Basic Building Code (BBC), the SBCCI Standard Building Code (SBC), and the ICBO Uniform Building Code (UBC) all contain the basic 25-50% Rule. The American Insurance Association (AInsA) National Building Code (NBC) contains reference only to restoration if cost exceeds 50%. All four of the codes are consistent in requiring that the entire building

be brought into compliance with current code requirements if the work exceeds 50% of the value of the building. The NBC apparently does not administratively address the issue if restoration costs are below 50% of value. Hence, the balance of this discussion is primarily directed to the three remaining models.

Both the BBC and SBC state that the physical value of the building will be determined by the building official. The BBC also states the value will be based on replacement cost.

All three models indicate that the rule applies only if the alteration or repairs are made within a 12-month period.

BBC and SBC differentiate between alterations exceeding 50% and repair of damages exceeding 50%. The 12-month period does not apply to a building damaged in excess of 50% in value.

b. Between 25-50%

Where the cost is between 25 and 50% of value, both BBC and SBC specify that the extent to which the portion of the building altered or repaired conforms to new construction requirements is left to the discretion of the building official. The UBC merely states that the addition, alteration or repair be made in conformance with the current code, provided that the entire building not exceed areas and heights specified by the code.

c. Under 25%

Where the cost of the alteration is under 25%, BBC and SBC essentially allow restoration with like materials with caveats that the public safety is not endangered or a non-conforming or hazardous use is not extended.

In the under 25% category, the UBC distinguishes between structural and non-structural alterations. For structural alterations, the changes must conform to new code requirements, unless they are minor, in which case the building official may approve replacement with like materials, provided that the entire building not exceed areas and heights specified by the code. Non-structural alterations and repairs can be made with like materials provided they do not affect any member or part of the structure having required fire resistance.

Jurisdictions that use the 25-50% Rule at times vary the terms from those in the model codes. Two examples are Los Angeles and Phoenix.

Los Angeles Department of Building and Safety Conservation Bureau Bulletin No. 32 states:

" Repair 'in kind' is permitted outside a fire zone in an amount of 50% of the replacement value of the building during a two-year period. In a fire zone, repair 'in kind' is permitted if the value of the work done in any one year is not in excess of 10% of the replacement value of the building.

A building is permitted to be 'non-conforming' in part or totally if the value of the required repairs does not exceed 50% of the replacement value of the building."

The City of Phoenix, Arizona reported the following information:

If Cost of Repair is:

0-10%	- Replace with like material
10-50%	- New work must meet code
Over 50%	- Entire building must meet code

In summary, the 25-50% Rule requires the upgrading of existing buildings to the performance levels required for new construction if work exceeds 50%, and allows various lower levels to continue to exist in buildings when lesser work is involved. It should be noted that the "alternate materials and methods" provisions of building codes, while generally applicable to all provisions of building codes, while generally applicable to all provisions of the codes, is not explicitly referenced in relation to compliance with the 25-50% Rule.

The 25-50% Rule has been the target of much criticism with regard to its effects on building conservation, rehabilitation and reuse. This criticism is underlined by the fact that originally the Rule was not intended to deal with rehabilitation. The drawback of the 25-50% Rule is that it is arbitrary, and it may unintentionally or by default, force a rehabilitated building into complete new construction code compliance, when the 50% is exceeded. Furthermore, the 25-50% Rule has an adverse effect on the rehabilitation of buildings of a low value, and may discriminate between similar buildings located in different real estate markets.

In terms of the conceptual diagram of performance levels discussed in A.3 above, the 25-50% Rule requires rehabilitated buildings to be upgraded to three potentially different levels of performance.

While the 25-50% Rule is likely to be eliminated from all the model codes in the forseeable future, it should be noted, however, that when used in close conjunction with the "alternate materials and methods" provision, and when applied to the lower range of values, the Rule is often seen as a flexible tool for the encouragement of rehabilitation, by explicitly extending the building's non-conforming rights. As such, it will be discussed later in this Guideline.

As stated previously, ICBO has eliminated the 25-50% Rule from the 1979 edition of the UBC and substituted the following wording:

Application to Existing Buildings and Structures

Sec. 104. (a) General. Buildings and structures to which additions, alterations or repairs are made shall comply with the requirements of this code for new facilities except as specifically provided in this section. See Section 1210 for provisions requiring installation of smoke detectors in existing Group R, Division 3 Occupancies.

(b) Additions, Alterations or Repairs. Additions, alterations or repairs may be made to any building or structure without requiring the existing building or structure to comply with all the requirements of this code provided the addition, alterations or repair conforms to that required for a new building or structure. Additions, alterations or repairs shall not cause an existing building or structure to become unsafe or overloaded. Any building so altered, which involves a change in use or occupancy, shall not exceed the height, number of stories or area permitted for new buildings. Any building plus new additions shall not exceed the height, number of stories and area specified for new buildings.

Alterations or repairs to an existing building or structure which are nonstructural and do not adversely affect any structural member or any part of the building or structure having required fire resistance may be made with the same materials of which the building or structure is constructed.

Exception: The installation or replacement of glass shall be as required for new installation.

BOCA intends to place a similar proposal before its membership at the January, 1980 Code Change Meeting.

In essence, the 1979 UBC Section 104(b) now requires that for additions, alterations, or repairs:

- new work must conform to the code,
- work shall not cause existing buildings to become unsafe or overloaded,
- altered buildings involving change in use or occupancy, and buildings undergoing addition, shall not exceed height and area required for new buildings, and
- non-structural work not adversely affecting a structural member or any part having required fire resistance may be done with same materials.

As compared to the former Sections 104(b) through 104(e) (25-50% Rule), the new section appears to accomplish the following:

- any amount of non-structural work can now be done with like materials, as compared to only if cost was 25% or less under prior rule,

- any new structural work must be in conformance with current code (constitutes no change from prior rule in the 0-50% bracket),

- with the caveats noted regarding overloading and height and area restrictions, the existing structure can remain without being brought up to new code requirements.

This UBC substitution for the 25-50% Rule requires the upgrading of rehabilitated buildings to a performance level somewhat lower than that required for new construction, while requiring new construction performance for specifically defined aspects.

(2) Change of Use or Occupancy

Building codes address change of use or occupancy in existing buildings by considering that such a change may introduce new or greater hazards and by requiring a careful reexamination to determine that the building will be safe for the new occupancy.

The three model building codes require, generally, that where a change in occupancy occurs, the building must be made to comply with the requirements of the current building code for the new occupancy. The model codes state this in various ways.

The 1978 BOCA Basic Building Code addresses changing use in three sections.

Section 105.2 Change in use:

"It shall be unlawful to make any change in the use or occupancy of any structure which would subject it to any special provision of this code without approval of the building official, and his certification that such structure meets the intent of the provisions of law governing building construction with a proposed new use in occupancy, and that such change does not result in any greater hazard to public safety or welfare."

Section 119.2 Buildings hereafter altered:

"A building or structure hereafter enlarged, extended or altered to change from one use group to another or to a different use within the same use group, in whole or in part, and a building or structure hereafter altered for which a certificate of use and occupancy has not been heretofore issued, shall not be occupied or used until the certificate shall have been issued by the building official, certifying that the work has been completed in accordance with the provisions of the approved permit; except that any use or occupancy, which was not discontinued during the work of alteration, shall be discontinued within thirty (30) days after the completion of the alteration unless the required certificate is secured from the building official."

Section 119.4 Changes in use and occupancy:

"After a change of use has been made in a building or structure, the reestablishment of a prior use that would not have been legal in a new building of the same type of construction is prohibited unless the building complies with all applicable provisions of this code. A change from one prohibited use, for which a permit has been granted, to another prohibited use shall be deemed a violation of this code."

Section 101.4(3) of the 1979 Standard Building Code states:

"If the occupancy of an existing building is entirely changed the building shall be made to conform to the requirements of this code for the new occupancy. If the occupancy of only a portion of an existing building is changed and that portion is separated from the remainder as stipulated in Section 403, then only such portion need be made to conform."

Section 502 of the 1979 Uniform Building Code states:

"No change shall be made in the character of occupancies or use of any building which would place the building in a different division of the same group of occupanices, unless the building is made to comply with the requirements of this code for such division or group of occupancy

Exception: The character of the occupancy of existing buildings may be changed subject to the approval of the building official and the

building may be occupied for purposes in other groups without conforming to all the requirements of this code for those groups, provided the new or proposed use is less hazardous, based upon life and fire risk, than the existing use."

The SBC unambiguously requires compliance with current code provisions. The UBC is similar, but includes the Exception which waives compliance with all current code provisions (i. e., requires compliance with some only). The Exception is in performance language, and the enforcement official must determine whether the proposed use is less hazardous based on life and fire risk than the existing use. The UBC does not define "life and fire risk." A decision must be made whether it was intended to apply to property damage as well as to life safety of the occupants.

The BBC appears to give the enforcement official the greatest leeway (of the three model codes) in determining the extent to which compliance with current code provisions would be required.

In summary, the model codes vary in their requirements for rehabilitation involving a change in use or occupancy. At one extreme they require upgrading to the performance levels of new construction. At the other, they require selective upgrading, based on undefined hazard and risk analyses. Here also, as in the case of the 25-50% Rule, explicit reference to the "alternate materials and methods" provision in cases of change or use or occupancy is not made.

B.2 "CODE ENFORCEMENT GUIDELINES FOR RESIDENTIAL REHABILITATION", PUBLISHED BY BOCA

The above document, the first edition of which was published in 1975, was developed by BOCA, ICBO, SBCCI and AInsA on the basis of research sponsored by the U. S. Department of Housing and Urban Development.

The document is currently published as Appendix B to the 1978 BOCA Basic Property Maintenance Code.

The extent and nature of the application of this document to residential rehabilitation in local communities is not knows at this time.

B.3 POSSIBILITY OF CONFLICTING GOALS OF REGULATIONS AND REHABILITATION

Building regulations, as discussed earlier, are intended to implement goals of private and public health, safety, welfare and property protection in the occupancy and use of buildings. These goals are usually not explicitly stated by a community. Their achievemtnt through the enforcement of building regulations imposes certain costs on building owners and on society.

Programs of building conservation, rehabilitation and reuse are also initiated by communities in the furtherance of certain goals. These goals may relate to avoiding the reduction of the existing housing stock. Other goals may relate to preventing the deterioration of downtowns or of industrial areas.

It is useful for any community to realize, whether explicitly or implicitly, that its goals underlying rehabilitation may conflict with its goals underlying building regulation. In such a case, the enforcement of building regulation will not support the community's rehabilitation goals. Specifically, current building regulation may force the upgrading of rehabilitated buildings to the levels required for new construction (as discussed above), which may impose an unacceptable cost on rehabilitation and may prevent rehabilitation from taking place.

If a community finds that its regulation and rehabilitation goals are potentially in conflict, it may determine that in the interest of furthering rehabilitation, some reduction in the levels of safety, health, welfare and property protection required of rehabilitated buildings may be acceptable. A community which develops a rehabilitation policy on the basis of such a determination will find the concept of the various levels of performance introduced in A.3 above useful in implementing such a policy. The concept may help the community to set specific standards and requirements for rehabilitation, different from the regulation currently in effect.

Such standards and requirements may imply lower levels of performance than required for new construction, while reflecting acceptable levels of safety for the community.

The following diagram illustrates the levels of performance of a specific existing building, in relation to the performance level required by various regulations in effect.

It suggests the potential benefits of establishing specific requirements for building rehabilitation, because in their absence the current 25-50% Rule and change of occupancy provisions often force the building up to the performance levels of the new construction codes.

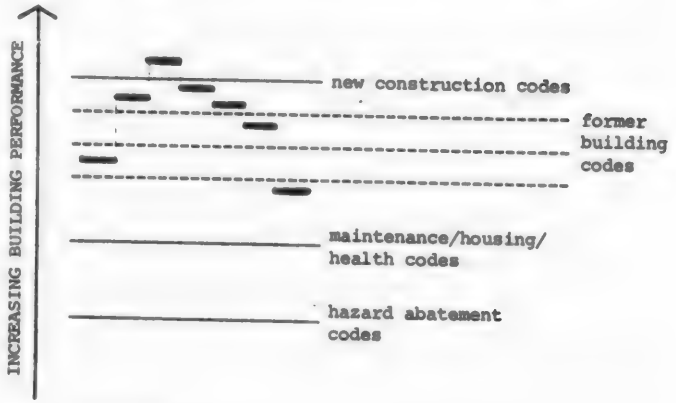

Diagram 2. Conceptual Diagram of the Performance Range of an Existing Building's Various Characteristics Compared to Levels Implied by Building Regulations

C. HISTORIC PRESERVATION WAIVER CLAUSES

A discussion of the state-of-the-art of regulation of building rehabilitation would not be complete without mentioning historic preservation. Historic preservation is a specific problem, and in addressing it the building regulatory system has accepted the fact that in achieving the policy goals of historic preservation, some compromise with the health and safety goals of the regulatory system may be required. This compromise has been recognized by the model code groups.

The 1978 BOCA Basic Building Code states:

Section 316.0 SPECIAL HISTORIC BUILDINGS AND DISTRICTS

"316.1 Approval: The provisions of this code relating to the construction, repair, alteration, enlargement, restoration and moving of buildings or structures shall not be mandatory for existing buildings or structures identified and classified by the state and/or local government authority as historic buildings, subject to the approval of the board of appeals when such buildings are judged by the building official to be safe and in the public's interest of health, safety and welfare regarding any proposed construction, alteration, repair, enlargement, relocation, and location within the fire limits. All such approvals must be based on the applicant's complete submission of professional architectural and engineering plans and specifications bearing the professional seal of the designer."

Section 104.(j) of the 1976 Uniform Building Code states, similarly:

"(j) Historic Buildings. Repairs, alterations and additions necessary for the preservation, restoration, rehabilitation or continued use of a building or structure may be made without conformance to all of the requirements of this Code, when authorized by the Building Official provided:

1. *The building or structure has been designated by official action of the legislative body as having special historical or architectural significance.*

2. *Any unsafe conditions as described in Section 203, will be corrected in accordance with approved plans.*

3. *Any substandard conditions will be corrected in accordance with approved plans.*

4. *The restored building or structure will be less hazardous, based on life and fire risk, than the existing building."*

Briefly, buildings may be exempted from full code compliance either individually, as a landmark, or collectively

in an historic district. The designation as a landmark or as an historic district may be made by local public landmarks/historic district commissions, and may rely to varying degrees on state public historic preservation offices or on listing in the National Register.

Over 600 cities in the United States currently have such exemptions in effect.

D. SOME CURRENT REGULATORY INNOVATIONS RELATED TO BUILDING REHABILITATION

Several specific examples of direct approaches to the regulation of building rehabilitation, rather than the building codes' indirect approach through the 25-50% Rule and the change of occupancy regulations are discussed briefly below. Fuller discussions and documentation of each example are included in the Appendices.

All the examples establish a set of requirements applicable to rehabilitation, and each, to varying degrees, reflects a reduction in the total set of requirements applicable to new construction. In other words, each example is a regulatory innovation which addresses the problem of setting standards for rehabilitation, and may be thought of as requiring a level of performance below the upper level implied by codes for new construction (see A.3 above).

Each regulatory innovation is likely to have grown or evolved out of a very specific set of physical and social conditions, and to have been intended to solve specific local problems.

The following examples of regulatory innovation are suggested for consideration; they are not intended to form an exclusive or comprehensive list, and similar regulatory innovations may exist elsewhere:

- Washington, D. C. (Appendix 6)
- San Francisco, California (Appendix 7)
- Denver, Colorado (Appendix 5)
- State of Massachusetts (Appendix 8)
- City of Los Angeles Seismic Regulation in Cases of Change of Occupancy (Appendix 9)
- State of California Seismic Safety Commission Draft Legislation Related to Seismic Hazards (Appendix 10)
- Chapter 10 of the Official Electrical Code of the City of Detroit (Appendix 11)

The examples fall into two categories:

- Comprehensive approaches
- Partial approaches

D.1 COMPREHENSIVE APPROACHES

Examples of comprehensive approaches can be found in Washington, D. C.; San Francisco, California; Denver, Colorado; the State of Massachusetts. These approaches are comprehensive because each one of them has developed an innovative regulatory system which addresses all aspects of rehabilitation of buildings in most, or all, occupancies.

(1) Washington, D. C.

Washington's code includes neither the 25-50% Rule nor the general change in use regulations. In their place, the code contains prescriptive provisions specifically addressing existing buildings, and specific provisions applied when a change in use occurs. In general, the code requires several levels of performance in increasing order:

a) Code in effect when building was erected

b) Retroactive provisions

c) Provisions concerning alteration or conversion

d) Provisions for new construction.

The code incorporates a hazard ranking by occupancy type and intensity of use. Conversion is defined as a change to a higher hazard use. Alteration is defined as work which affects egress arrangements or fire resistivity.

The code provisions were developed over a long period of time, and are based on the approach of allowing certain deviations from the requirements for new construction for existing, altered or converted buildings.

Prescriptive requirements for rehabilitation may be effective in an urban jurisdiction such as Washington, D. C. where a large number of older buildings are known, and pose similar problems for rehabilitation. More prescriptive requirements may be needed to cover the range of rehabilitation problems encountered in jurisdictions with a more varied or diverse building stock.

(2) San Francisco, California

San Francisco's code, like Washington's, includes neither the 25-50% Rule, nor the general change in use regulation. In their place the code contains specific provisions applicable to work on existing buildings. In general, these provisions are:

a) Enforcement of the housing code, with specific tolerances established by an inspection manual, for all existing housing and housing rehabilitation. This establishes a lower level of performance than required for new construction.

b) Requirements pertaining to structural alteration work. These may be lower than new construction requirements, except when structural alteration exceeds a specified quantitative limit.

c) Requirements pertaining to architectural alteration work. These require that only new work meet new construction requirements, except when work exceeds a specified quantity on a floor, in which case floor-by-floor compliance with new construction requirements is required only.

d) Specific requirements for additions.

e) Provisions for covering change of occupancy, requiring either full compliance with new construction requirements or two lower levels of compliance, as a function of the specific occupancies involved in the change, and based on relative hazard of the occupanices.

San Francisco's approach is particularly notable for its use of the housing code and its companion inspection manual in rehabilitation of housing. As in the case of Washington, D. C., this approach is effective in an urban jurisdiction where a large number of older buildings are known and pose similar problems for rehabilitation, and, as in San Francisco, where much of this building stock consists of housing.

(3) Denver, Colorado

Unlike Washington and San Francisco, the Denver building code includes both the 25-50% Rule and the general change of occupancy regulation. However, in apparent recognition of the inadequacy of these regulations to support Denver's rehabilitation needs, the City of Denver has enacted a special chapter on "Rehabilitation of Older Buildings" into its building code (Chapter 31). This chapter achieves several results:

a) It exempts buildings of specific occupancies erected before 1950 from code compliance under the 25-50% Rule and the change of occupancy regulation.

b) It declares rehabilitation of older buildings to be a public necessity as a matter of policy.

c) It establishes an administrative mechanism for developing guidelines to be used by the building official in accepting deviations from code requirements in cases where the rehabilitator requests such deviations.

Thus, Denver's regulatory innovation is to explicitly permit deviations from strict code compliance in the case of rehabilitation. It is unclear whether Denver's guidelines imply reduced levels of performance for rehabilitation when compared to new construction requirements, or whether they merely encourage the acceptance of alternative solutions of equivalent performance. Denver's approach is too recent to provide a response to this question.

(4) State of Massachusetts

Until June, 1979, the State building code in Massachusetts included the 25-50% Rule and the general

change of occupancy regulation (the BOCA code version). On that date the State enacted Article 22, representing a regulatory innovation replacing the 25-50% Rule and the change of occupancy regulation.

In general, Article 22, contains the following:

a) Definition of hazardous conditions, related to structural performance, number of exits and capacity of exits, the elimination of what must be complied with in all existing buildings.

b) Classification of all occupancies into one of eight hazard classifications, in increasing order of hazard.

c) Establishment of three levels of required performance for rehabilitated buildings (above the level of hazard elimination noted in (a) above). These levels are a function of the relative change in hazard classification involved in the rehabilitation, and range from a requirement of not reducing the level of performance of the existing building to full compliance with the requirements for new construction.

d) Explicit encouragement of acceptance of equivalent alternative solutions whenever compliance with new construction requirements is specified.

In summary, the Massachusetts approach is based on the philosophy that the existing building's actual level of performance establishes the level to be complied with in rehabilitation, except for the elimination of a few specified hazards, and except when changing occupancy to one of substantially greater hazard. In other words, the Massachusetts approach to rehabilitation requires compliance with many different potential levels of performance (potentially the number of levels is the number of existing buildings).

There is not yet enough experience to judge the efficacy of this approach, and specifically the efficacy of basing levels of compliance on a single number hazard index of occupancies.

D.2 PARTIAL APPROACHES

Partial approaches to regulatory innovation related to rehabilitation of existing buildings are those which address a specific problem, be it a single hazard (e.g., seismic loading), a single building component (e.g., electrical system), a single class of buildings (e.g., residential), or any other problem for rehabilitation.

Three examples of partial approaches to regulatory innovation are discussed below and in the appendices.

(1) City of Los Angeles Seismic Regulation in Cases of Change of Occupancy

This regulatory innovation deals only with seismic loads, and illustrates the conscious reduction in requirements applicable to rehabilitation involving a change in occupancy.

The City of Los Angeles has developed a "Rule of General Application" (RGA) to determine when buildings undergoing a change of occupancy or having an increase in the occupant load must be made to conform to current structural requirements. A copy of the rule is included in Appendix 9. A portion of the rule reads as follows:

> *"In buildings constructed on or after October 6, 1933, a change in occupancy may be made to establish any occupancy classification provided the building is not substantially altered."*

The October 6, 1933 date was selected since all buildings constructed in the City of Los Angeles subsequent to October 6, 1933 were required to be designed for earthquake forces. This provision is based upon buildings located in areas subject to seismic forces of the magnitude anticipated in Seismic Zone 4. It is recognized that the level of seismic design force would not be as required under the current building code. However, the building should perform in such a manner as to minimize life loss in the event of an earthquake.

This RGA contains a list of occupancies arranged in order from the least hazardous to the most hazardous. An occupancy or use is generally considered more hazardous as the occupant load within the building or the length of time the building is occupied are increased. (An exception to this occurs in category No. 4 which would include retail stores which could contain a considerable number of occupants. It would seem desirable to include retail stores with a considerable number of occupants in category 5 or 6.)

Note that an occupancy hazard listing based on structural performance may not be applicable when fire safety of the occupants is a consideration.

(2) State of California Seismic Safety Commission Draft Legislation Related to Seismic Hazards

In areas subject to earthquakes, it is well known that unreinforced masonry buildings which have not been designed for seismic effects may be subject to severe damage in moderate earthquakes. Based upon this fact, the Seismic Safety Commission of the State of California is developing legislation related to buildings which would be a hazard when subjected to the level of seismic forces which could be encountered in the State of California. A draft of the proposed legislation is contained in Appendix 10.

This example of regulatory innovation is a form of a hazard abatement code, and is intended to eliminate the problem of complying with portions of the new construction code in removing a particular hazard.

In part, the draft states:

> *"This bill would authorize a city, city and county, or county to establish construction standards for reconstruction of existing buildings determined, as specified, to be a hazard to life in the event of an earthquake, which standards are as specified in the bill and would eliminate the problem of complying with the latest building code governing new construction when rehabilitating older buildings."*

(3) Chapter 10 of the Official Electrical Code of the City of Detroit, Adopted November 9, 1977 ("Minimum Standards for Existing Dwelling Units")

This Chapter (see Appendix 11) was developed by the City of Detroit and has been proposed for the National Electrical Code. It reflects that city's need to rehabilitate large numbers of single family houses.

Chapter 10 covers the re-wiring of existing inadequately wired dwelling type occupancies. It describes the evidence of inadequacy of wiring, and defines minimum illumination and power requirements for each room or space of the dwelling.

Chapter 10 represents a regulatory innovation because the National Electrical Code does not specifically address existing buildings, and its requirements establish levels of performance for new construction. Chapter 10 establishes lowmr levels of performance which would be safe and acceptable for existing buildings.

PART II

IDENTIFYING EXISTING CONDITIONS IN A COMMUNITY

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The purpose of this Part of the Guideline is to provide policymakers or other interested groups in a community with a procedure for examining the existing conditions in their community to determine what problems, if any, are posed by the existing regulatory system in setting standards for building rehabilitation and re-use. The procedure makes reference to the general introduction and background discussions in PART I of the Guideline, and consists of three steps:

- Define existing regulatory systems.
- Define pertinent characteristics of building rehabilitation in the community.
- Identify potential problems.

With the identification of problems, policymakers can proceed to PART III of the Guideline, in which recommendations for amending the regulatory system designed to solve the respective problems are discussed.

A. DEFINE EXISTING REGULATORY SYSTEM

Buildings in a community may be regulated by means of a variety of regulations, as discussed in Introduction and Background. It is necessary to define how they are regulated in a particular community. In doing so, it will be useful to make use of the conceptual diagrams of required building performance presented in the Introduction and Background.

The definition of the existing regulatory system consists of three parts:

- Define those requirements imposed on all existing buildings, and their enforcement.
- Define new construction requirements and their enforcement.
- Define existing provisions addressing building rehabilitation and reuse.
- Compare criteria levels.

A.1 DEFINE THOSE REQUIREMENTS IMPOSED ON ALL EXISTING BUILDINGS, AND THEIR ENFORCEMENT.

(1) Hazard Abatement Code

(a) Determine whether a code for the abatement of dangerous buildings, or a similarly titled document, is in effect as a hazard abatement code in the community. Note that similar provisions may be part of the building code.

(b) If such a code, or provisions, are in effect, determine whether they include explicit criteria for various enforcement options by the authority having jurisdiction. Such criteria may be found in inspection manuals or similar ancillary documents as well as in the regulations themselves. Specifically, determine whether the code contains a workable definition of "imminent hazard," warranting immediate remedial action to be enforced by the authorities. If the criteria are defined by reference to another code (e.g., building code, electrical code, etc.), the explicit criteria should still be identified.

(c) Exhibit the criteria for "imminent hazard" and for other hazards covered by the hazard abatement code, in the categories of structural safety, fire safety, health and hygiene, and any further breakdown of these categories as appropriate.

(d) Determine how the hazard abatement code is enforced, and by what agency. Specify whether its enforcement is a function of location within the community, and if so, specify how. Specify whether the code is enforced differently in different occupancies or types of buildings.

(e) Determine how the hazard abatement code's enforcement is triggered. Specify if it is triggered uniformly for all buildings or classes of buildings, or whether it is triggered by actions other than the mere presence of the hazard, such as application for a building permit.

(2) Property Maintenance/Housing Codes

(a) Determine whether a housing code, property maintenance code, fire prevention code, health code, or any other regulation which may similarly cover the maintenance, operation and use of buildings, are in effect in the community. Some of these provisions may be part of building, mechanical, plumbing or electrical codes. For all such codes in effect, determine whether they include explicit criteria for various enforcement options by the authority having jurisdiction. Such criteria may be found in ancillary inspection manuals, or may be specified by reference to the building, mechanical, plumbing or electrical codes.

(b) Exhibit the criteria for various enforcement actions contained in these codes, in the categories of structural safety, fire safety, health and hygiene, and any further breakdown of these categories as appropriate.

(c) Determine how each of these maintenance codes is enforced, and by what agency. Specify whether each code's enforcement is a function of location within the community (e.g., target neighborhoods for housing code enforcement). Specify whether each code's enforcement is varied as a function of occupancy or building type (e.g., active housing code enforcement in nursing homes, active fire prevention code enforcement in public assembly occupancies, etc.).

(d) Determine how the enforcement of each maintenance code is triggered. Specify how violations of these codes are brought to the attention of the authorities, and whether the codes' enforcement is triggered uniformly for all buildings, classes of buildings, neighborhoods or similar classifications, or whether it is triggered by actions independent of the normal operation, maintenance and use of existing buildings, such as application of a building permit.

(3) Retroactive Regulations

(a) Identify all retroactive regulations currently applicable to existing buildings in the community.

(b) For each retroactive regulation, identify the unsafe or undesirable conditions which the regulation is intended to correct. Specify whether the regulation applies to all buildings, to specific occupancies or building types, or to any other limited category of buildings.

(c) For each regulation, determine the criteria which must be met for compliance. These criteria may be established by reference to the building code or some other code.

(d) Exhibit the criteria for compliance with each retroactive regulation in the categories of structural safety, fire safety, health and hygiene, as applicable.

(e) Determine how each retroactive regulation is enforced, and by what agency. Specify whether the enforcement is a function of location within the community, or of any categorization of buildings (e.g., by occupancy, type, age, condition, etc.).

(f) Determine how the enforcement of each retroactive regulation is triggered. Specify how deficiencies are brought to the attention of the authorities. Determine whether the enforcement is triggered by actions which are independent of the presence of the specific deficiencies, such as application for a building permit.

A.2 DEFINE NEW CONSTRUCTION REQUIREMENTS AND THEIR ENFORCEMENT

(a) Identify all existing codes currently applicable to new construction in the community. These may include a building code, mechanical code, plumbing code, electrical code, various specialty codes, life safety codes and special regulations.

(b) Determine the occupancy and use categories into which buildings are classified by the codes. Determine fire districts, or other locational categories into which buildings are classified by the codes.

(c) For each building classification, determine which must be met for compliance.

(d) Categorize these criteria into the same, or similar categories to those utilized for displaying the criteria for the codes and regulations applicable to existing buildings as specified in the preceding section. Display the criteria in these categories to the extent and level of detail possible.

(e) Describe how the codes covering new construction are enforced, and by what agencies. Include in this description any cross referencing or interagency coordination employed in the enforcement. If code enforcement is carried out by various levels of government (state, county), it should be fully described. Determine the mechanisms for triggering code enforcement activities, such as application for building permits, mechanical permits, electrical permits, etc.

A.3 DEFINE PROVISIONS COVERING BUILDING REHABILITATION

(1) 25-50% Rule

(a) Determine whether the community's building code includes the 25-50% Rule or similar rule covering building repair and alteration. Determine whether a similar rule is included in the mechanical, plumbing and electrical codes.

(b) Determine how the building code addresses additions to existing buildings.

(c) If the 25-50% Rule, or similar rule, is in effect, determine the criteria that are required for compliance when rehabilitation work falls into one of the following three categories:

- under 25%
- 25-50%
- over 50%

(d) Determine whether reference is made to any other codes (e.g., the code under which the building was originally built) in establishing these criteria.

(e) Display the criteria for compliance in the same categories as those utilized in the preceding section.

(f) If the 25-50% Rule, or similar rule, is in effect, determine how it is enforced. Specify how the value of the numerator (value of repair and alteration work) is determined in terms of work items covered and cost estimates. Specify how the value of the denominator (value of the existing building) is determined.

(g) Determine whether the 25-50% Rule is enforced uniformly for all buildings, or whether its enforcement differentiates between classes of buildings on any basis.

(h) Determine whether the 25-50% Rule discriminates against certain building owners or certain neighborhoods in the community, by resulting in the imposition of different criteria for similar rehabilitation of similar buildings.

(2) Change of Occupancy

(a) Determine the current regulation governing code compliance of existing buildings involved in a change of occupancy. Usually this regulation is part of the building code.

(b) Determine whether the change of occupancy regulation requires full compliance with all code requirements for new construction of the occupancy proposed, or whether only partial compliance is required. if partial compliance is included in the regulation, determine whether it is based on a systematic ordering of occupancies in terms of hazard, or on a similar defined analytical procedure.

(c) If partial compliance is included, determine the criteria which are established for each category of occupancy change, and display the criteria in the same categories as those utilized in the preceding section.

(d) Determine how the change of occupancy regulations are enforced, and whether they are enforced uniformly throughout the community.

(3) Other Rehabilitation Provisions

(a) Identify all other provisions which may affect building rehabilitation in the community. These may include historic preservation waivers, landmark provisions, general building rehabilitation provisions, etc. Some of these may be included in ancillary inspection manuals or similar documents.

(b) Determine what criteria are specified for compliance with any such special provison, and display them in the same categories as those utilized in the preceding section.

(c) Determine how these special provisions are enforced, including use of advisory boards, review panels, appeals boards, etc.

A.4 COMPARE CRITERIA LEVELS

Compare the displays of the various sets of criteria included in all elements of the existing building regulatory system in the community which were defined and displayed under A.1-A.3 above. This comparison may take the form (graphically or conceptually) of the conceptual diagram included in Part I of this Guideline. In such an approach, the criteria for new construction are likely to define an upper limit of performance. The requirements imposed on existing buildings are likely to define a lower limit of performance. The existing regulations governing building rehabilitation will define where different categories of rehabilitation are required to fall between these two limits.

This comparison and display of criteria levels will identify for policymakers the extent of upgrading required for rehabilitated buildings by the existing regulatory system, and will enable them to determine whether this upgrading is consistent with local rehabilitation policies.

B. DEFINE PERTINENT CHARACTERISTICS OF BUILDING REHABILITATION IN THE COMMUNITY

Building rehabilitation in a community is a function of many factors, such as:

- physical characteristics of the community
- age and condition of the building stock
- economic conditions of development
- socio-economic conditions in the community
- regulatory system and its history
- public policy at the federal, state and local levels of government.

It is necessary to define the following pertinent aspects of building rehabilitation, and their relationship to some of these factors:

- Define occupancies involved or potentially involved in rehabilitation.
- Define building ages and types involved or potentially involved in rehabilitation.
- Determine extent of illegal rehabilitation.
- Define existing rehabilitation policies.

B.1 DEFINE OCCUPANCIES INVOLVED OR POTENTIALLY INVOLVED IN REHABILITATION

Determine whether building rehabilitation in the community is principally a matter of upgrading or re-use of existing occupancies (e.g., residential

rehabilitation, commercial rehabilitation, etc.), or whether it is a matter of changing occupancies (e. g., commercial to residential, residential to commercial, residential to assembly, etc.) This can be determined both by observing actual current rehabilitation projects, as well as by identifying potential candidates for rehabilitation (which due to existing problems or constraints may not be currently undergoing rehabilitation).

The nature of occupancy changes involved in rehabilitation is often related to the changing nature of neighborhoods and of the community as a whole, and is therefore subject to the economic conditions of development, socio-economic and physical characteristics of the community.

It is important to define the occupancies involved, or potentially involved in rehabilitation, because the building regulatory system is likely to treat rehabilitation involving occupancy change very differently from that in which no change is involved. In general, the former is likely to entail the enforcement of higher levels of performance in the rehabilitated building. For this reason it is also necessary to determine the extent to which the occupancy classifications contained in the community's building code (see A.2 above) correspond to, or fit with, the actual uses of buildings being rehabilitated. If this correspondence, or fit, is not clear, then the regulatory system will involve ambiguities in dealing with change of occupancy rehabilitation.

B.2 DEFINE BUILDING AGE AND TYPES INVOLVED OR POTENTIALLY INVOLVED IN REHABILITATION

Determine the age and principal characteristics (structural, architectural, mechanical) of buildings involved, or potentially involved in rehabilitation work in the community. This can be determined by both observing current projects as well as identifying potential candidates for rehabilitation.

While the age and principal characteristics of buildings are mainly a part of the general physical characteristics of the community, it must also be analyzed in relation to the history of the building regulatory system in the community. Such an analysis will determine the extent of the disparity between the characteristics and performance of the existing building stock and the current code requirements for new construction. For example, a community where most of the buildings are 25 years old, and where there have been very few code changes during that period, will have very different problems of regulation of rehabilitation than a community with buildings over 50 years old and with a history of numerous code changes. Washington, D. C. and San Francisco fall into the latter category, which may explain the specific nature of their regulatory approach to rehabilitation (as discussed in PART I of this Guideline.)

B.3 DETERMINE EXTENT OF ILLEGAL REHABILITATION

Illegal rehabilitation is the practice of carrying out repairs and alterations in buildings without the permits required for such work by a community's regulatory system. It is necessary to determine the extent and nature of such rehabilitation occurring in the community, and to identify the classes of building in which it is occurring, because this characteristic may indicate the effectiveness of the regulatory system in dealing with rehabilitation. The extent and nature of this phenomenon may also help in identifying potential problems of safety, health and hygiene which should be addressed by the regulatory system for rehabilitation.

B.4 DEFINE EXISTING REHABILITATION POLICY

Identify all the current policies related to building and neighborhood rehabilitation which are in effect in the community. These policies may be federal (expressed by the community's acceptance of federal assistance), state or local.

Specify the building classes or types which are addressed by the rehabilitation policy.

Attempt to determine the relative real costs which these rehabilitation policies intend for the community to bear. For example, how much, if any, relative safety, convenience and other features should the community be willing to give up in order to achieve the goals of the rehabilitation policies.

C. IDENTIFY POTENTIAL PROBLEMS

The following conditions found in the community could indicate problems in need of solution:

(1) Conflict between the goals of rehabilitation and the goals of building regulation

While the health and safety goals of the building regulatory system are usually not made explicit in a community, the conflict between rehabilitation goals and regulation goals may be determined by the community if it finds that current building regulations force the upgrading of rehabilitated buildings to levels of performance which impose unacceptable cost on rehabilitation and prevent much rehabilitation from taking place, thereby failing to meet rehabilitation goals.

The community may also determine that such a conflict exists between rehabilitation and regulation goals when the enforcement of the regulations on existing buildings (hazard abatement codes, property maintenance codes and retroactive regulations) is triggered only by application for building permits, in which case the enforcement system is discriminating against all rehabilitation activities of the community, by enforcing regulations that should apply to all existing buildings.

(2) Discrimination of current rehabilitation regulations against a class of buildings or owners

This condition may occur in a community which applies the 25-50% Rule to rehabilitation, as discussed above.

(3) Violation of existing regulations

The existence of extensive illegal rehabilitation work in the community, as discussed above, is evidence of this condition.

The above conditions may indicate the existence of one or more of the following four problems, listed in increasing order of the required modification to the regulatory system. Each problem is defined in PART III of this Guideline, where recommendations are made for solutions.

1. NO MODIFICATION IN CURRENT REGULATORY SYSTEM (25-50% RULE AND CHANGE OF OCCUPANCY REGULATION) IS NEEDED

2. FLEXIBLE APPLICATION OF THE 25-50% RULE IS NEEDED

3. EXISTING REGULATORY SYSTEM, IN ITS RELATION TO BUILDING REHABILITATION, IS IN NEED OF MODIFICATION

4. A DEFINITION OF IMMINENT HAZARDS IS NEEDED IN THE REGULATORY SYSTEM

PART III

RECOMMENDATIONS FOR AMENDING OR MODIFYING

THE REGULATORY SYSTEM TO ENCOURAGE REHABILITATION

****

The following recommendations are established for each of the four problems defined in the preceding part of this Guideline. In general, a community will find that it is faced with one or more of these problems. All communities, however, should refer to the accompanying Statutory Guideline for Building Rehabilitation, Guideline for Managing Official Liability Associated with Building Rehabilitation, and the Guideline for the Municipal Approval of Building Rehabilitation for recommendations which are consistent with all four problems.

1. NO MODIFICATION IN CURRENT REGULATORY SYSTEM (25-50% RULE AND CHANGE OF OCCUPANCY REGULATION) IS NEEDED

Problem

The community determines that its current building code provisions applicable to rehabilitation, including the triggering of full code compliance by the 25-50% Rule and by the change of occupancy regulation, do not represent conflicts with rehabilitation goals, do not intentionally unduly constrain building rehabilitation and do not discriminate against classes of buildings or owners. Such a community accepts the imposition of new construction standards on much of its rehabilitation. However, the community determines that rehabilitation is unintentionally constrained by the prescriptive nature of many building code requirements.

Recommendations

The community should do the following:

(a) Explicitly justify, as a matter of public policy, each code requirement which is applied by current regulations to rehabilitated buildings, and which is in excess of the current requirements applicable to existing (unrehabilitated) buildings (e.g., hazard abatement code, property maintenance code and retroactive regulations).

(b) Amend the building code, electrical code, plumbing code, etc. to explicitly mention the acceptability of alternate materials, methods of construction and design when dealing with buildings under the 25-50% Rule and with buildings undergoing a change of use or occupancy.

(c) Implement the following technical Guidelines attached hereto:

- Egress Guideline for Residential Rehabilitation
- Electrical Guideline for Residential Rehabilitation
- Plumbing DWV Guideline for Residential Rehabilitation

In general, each of these guidelines suggests alternative solutions providing equivalent performance as specified by current codes, which are recommended for building rehabilitation.

(d) Implement similar technical guidelines to those of (c) above, which may be developed and published from time to time, or develop and implement similar guidelines.

2. FLEXIBLE APPLICATION OF THE 25-50% RULE IS NEEDED

Problem

Current building regulations include the 25-50% Rule. The majority of building rehabilitation in the community does not involve a change in use or in occupancy. The community's goals are to encourage such rehabilitation, and the community is willing to accept a level of performance for its rehabilitated buildings which is lower than that required for new construction. However, the 25-50% Rule as currently enforced requires full code compliance in more cases than the community finds appropriate and/or discriminates against classes of buildings or owners in the community.

Recommendations

The community should consider the following:

(a) Defining Cost and Value

In any jurisdiction which has the 25-50% Rule and desires to interpret it to promote rehabilitation as much as possible, the objective is to obtain the lowest possible ratio of cost of rehabilitation (the numberator) to the value of the building (denominator). The definition of cost, therefore, should be as low as possible. Based upon case studies the following methods of defining cost are either in use or suggested by building officials. Except where noted, these interpretations may be made by the building official without changing regulations.

(i) Defining Cost of Rehabilitation (the numerator)

Objective: Obtain Lowest Possible Value

- Exclude all non-permit items such as painting and decorating, kitchen cabinets, landscaping, architect's fee, and the like.

- Exclude all items which require a separate permit and which are normally covered by a separate code not governed by the 25-50% Rule, such as plumbing, electrical and elevator.

(ii) Defining Value of the Building (the denominator)

Objective: Obtain Highest Possible Value

- Define value as current replacement cost before rehabilitation, and update at least annually.

- Define value as current replacement cost after rehabilitation. (May not be feasible under the Standard Building Code since it requires the "then" physical value, presumably before rehabilitation. Also, the BOCA Basic Building Code implies replacement value before rehabilitation although not specifically stated).

- Assessed value is reportedly used in some jurisdications, but in general assessed value lags behind true replacement value. In addition, assessing practices often assess various occupancies using different methods which could lead to discrimination.

(b) Varying the Percentages

Consider increasing the percentages (e.g., 33-66% instead of 25-50%). This will tend to allow more rehabilitation before encountering new code requirements. To implement this change, a code amendment is required.

(c) Reduce the Time Span

The model codes and most local codes require that for purposes of the 25-50% Rule cost be defined as work done within one year. Reducing the time span to six months, for example, would tend to allow phased upgrading of buildings. This change, also, requires a code amendment.

(d) Condiser the use, or possible modification (to reflect an acceptable lower level of performance), of the technical guidelines as suggested for the preceding problem.

3. EXISTING REGULATORY SYSTEM, IN ITS RELATION TO BUILDING REHABILITATION, IS IN NEED OF MODIFICATION

Problem

The Community determines that its current building regulations conflict with its rehabilitation goals by requiring upgrading of many or most of its rehabilitated buildings to the performance levels specified for new construction or even to some lower level, leading to unacceptably high costs of rehabilitation which unduly constrain building rehabilitation. Also, the community may determine that the regulatory system discriminates by enforcing existing building regulations in cases of rehabilitation only.

Recommendations

The community should do the following:

(a) Consider applying or adapting a current regulatory innovation.

or

(b) Develop its own local rehabilitation code, provisions or guidelines.

(a) Consider applying or adapting a current regulatory innovation.

Part I and the Appendix of this Guideline contain discussions of various existing comprehensive or partial regulatory innovations. These include:

- Washington, D. C.
- San Francisco, California
- Denver, Colorado
- State of Massachusetts
- Los Angeles, seismic regulation
- State of California draft legislation related to seismic hazards
- Chapter 10, Official Electrical Code of the City of Detroit

The community faced with this problem may consider adopting or modifying one or more of these regulatory innovations. Such a community should do the following:

(i) Analyze each innovation in detail, from the materials appended to this Guideline. This analysis should pay particular attention to the specific community characteristics (physical, social, economic, political, etc.) which led to the development of each regulation. Since each of the regulation examples was developed to respond to local community conditions and needs, a given community considering adopting such a developed regulation must be aware of the similarities and dissimilarities of its own community characteristics in relation to those of the model being analyzed. A level of performance acceptable in one community may not be acceptable in another.

Note that of the complete " solutions," Washington, D. C. and San Francisco use specific, and often prescriptive, provisions applicable to rehabilitation. These may have limited transferability to any but very similar cities. Denver provides a mechanism for dealing with every case individually, rather than establishing comprehensive provisions. Massachusetts uses an approach in which every building defines the level of performance to which it must be rehabilitated.

(ii) Based on the analysis, adopt and/or modify one of the model regulatory innovations.

(iii) Amend current codes appropriately, including deletion of the 25-50% Rule and/or the change of occupancy provisions. It must be realized that such deletions require the substitution of specific provisions. It should also be noted that by deleting the 25-50% Rule, a community may inadvertently have a deleterious effect on rehabilitation below 25%, which currently enjoys the continuation of non-conforming rights.

(iv) Consider the use, or possible modification (to reflect an acceptable lower level of performance), of the technical guidelines as suggested in the preceding problem.

(b) Develop local rehabilitation code or guidelines

If the community determines that none of the regulatory innovations are applicable, it should develop its own rehabilitation code, regulation or guidelines. It should proceed as follows:

(i) Determine the levels of performance required for all existing buildings by the current hazard abatement code, property maintenance code and retroactive regulations. As a minimum, all rehabilitated buildings must meet these levels. Note that in the absence of a current definition of "imminent hazard," the recommendations for Problem 4, below, should be followed.

(ii) If the community determines that higher levels of performance are to be required for rehabilitated buildings (involving no occupancy change, as well as involving change of occupancy), each such requirement should be individually justified, as a matter of public policy. The justification should cover structural safety, fire safety, health and hygiene.

(iii) Amend the current building code to delete all provisions dealing with repair and alteration of existing buildings (25-50% Rule and change of occupancy provisions).

(iv) If the proposed rehabilitation regulations will rely on direct reference to the current codes dealing with existing buildings, these codes should be analyzed for references to the building code, electrical code, mechanical code, plumbing code, etc., to ensure that all references leading to inconsistency are deleted.

(v) Consider the use, or possible modification (to reflect acceptable lower levels of performance), of the technical guidelines as suggested in the preceding problem.

A format and methodology for developing a local rehabilitation code, based on comparative analysis of rehabilitation needs with the code requirements for new construction, is presented in Appendix 12 of this Guideline.

4. A DEFINITION OF IMMINENT HAZARDS IN NEEDED IN THE REGULATORY SYSTEM

Problem

The community may have a need to define "imminent hazard." For a community facing any of the preceding three problems, the problem may be its desire but inability to establish compliance priorities for any level of performance.

For a community facing problem categories 2 or 3 above (i.e., considering acceptance of lower levels of performance for rehabilitated buildings), the problem may be the inability to establish the absolute lowest acceptable level of performance by requiring only the elimination of "imminent hazards" as a requirement attending rehabilitation.

Recommendations

To assist the community in assessing an "imminent hazard," the following attributes and criteria should be considered:

(a) Structural Safety

A building presents an imminent hazard:

(1) Whenever the stress in any materials, member or portion thereof, due to all dead and live loads, is more than one and one-half times the working stress or stresses allowed in the code for new buildings of similar structure, purpose or location.

(2) Whenever any portion thereof has been damaged by fire, earthquake, wind, flood or by any other cause to such an extent that the structural strength or stability thereof is materially less than it was before such catastrophe and is less than the minimum requirements of the code for new buildings of a similar structure, purpose or location.

(3) Whenever any portion or member or appurtenance thereof is likely to fail, or to become detached or dislodged, or to collapse and thereby injure persons or damage property.

(4) Whenever any portion of a building, or any member, appurtenance, or ornamentation on the exterior thereof is not of sufficient strength or stability, or is not so anchored, attached or fastened in place as to be capable of resisting a wind pressure of one-half of that specified in the code for new buildings of similar structure, purpose or location without exceeding the working stresses permitted in the code for such buildings.

(5) Whenever any portion thereof has racked, warped, buckled or settled to such an extent that walls or other structural portions have materially less resistance to winds or earthquakes than is required in the case of similar new construction.

(6) Whenever the building or structure or any portion thereof because of: a) dilapidation, deterioration or decay; b) faulty construction; c) the removal, movement or instability of any portion of the ground necessary for the purpose of supporting such buildings; d) the deterioration, decay or inadequacy of its foundation; or e) any other cause, is likely to partially or completely collapse.

(7) Whenever the exterior walls or other vertical structural members list, lean or buckle to such an extent that a plumb line passing through the center of gravity does not fall inside the middle one-third of the base.

(b) Number of Exits

A building presents an imminent hazard whenever less than two approved independent exitways serve every story (except as modified by current building code or by the accompanying Egress Guideline for Residential Rehabilitation).

(c) Capacity of Exits

A building presents an imminent hazard whenever any required door, aisle, passageway, stairway or other required means of egress is insufficient to comply with the current code section on exit capacity or is so arranged as to preclude safe and adequate means of egress (see Egress Guideline for Residential Rehabilitation).

(d) Other

A building presents an imminent hazard whenever conditions exist which in the code official's judgment would be cause for an otherwise fully code-complying building to be evacuated or padlocked, or for the site or other adjacent areas to be evacuated, barricaded or otherwise protected.

CHAPTER 2

GUIDELINE FOR MUNICIPAL APPROVAL

OF

BUILDING REHABILITATION

INTRODUCTION

Building departments regulate construction with procedures that, although designed primarily for new construction, are nevertheless imposed on the submittal, review, and approval of rehabilitation projects. Imposition of these procedures often results in rehabilitation project delays, submittal of unnecessary paperwork, unjustified increases in project costs, and other adverse impacts on building rehabilitation.

While post-permit inspection procedures for rehabilitation are generally similar to those of new construction (except that extra allowance must be made for unforeseen conditions), pre-permit procedures should vary considerably since permit approval must depend on assessing the known and unknown characteristics of buildings in-place rather than evaluating only the design documents that are the basis for new construction.

The following model submittal, review, and approval process for building rehabilitation should be adopted, in full or abbreviated form, by communities that wish to encourage rehabilitation.

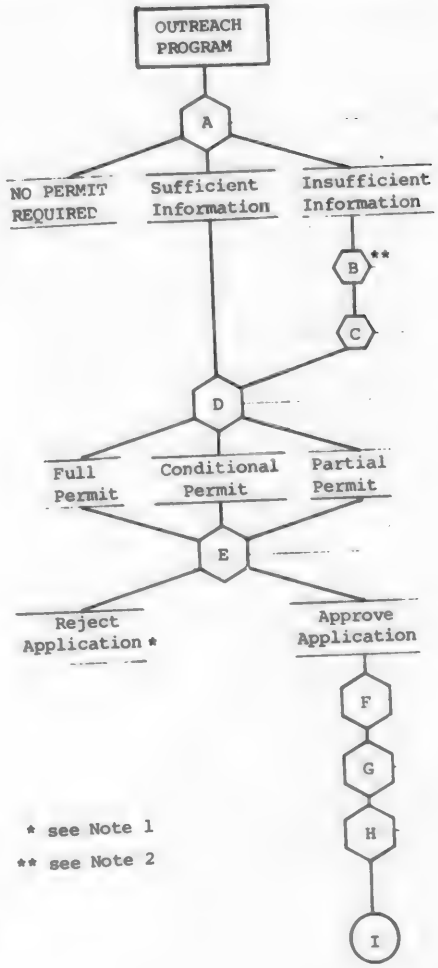

Figure 1

MODEL SUBMITTAL, REVIEW, AND APPROVAL PROCESS FOR REHABILITATION

MODEL SUBMITTAL, REVIEW, AND APPROVAL PROCESS FOR REHABILITATION

The following explanatory narrative is keyed to the diagram in Figure 1.

OUTREACH PROGRAM. Although not specifically a part of the submittal, review, and approval process, an Outreach Program, conducted by the building department or other municipal agency, can inform the building community, and the community at large, of the jurisdiction's requirements for rehabilitation. The program should provide information regarding:

- permits needed
- how to obtain them
- technical requirements of rehabilitation
- necessary inspections, and when they must occur
- related regulatory and procedural matters

STEP A

PRELIMINARY MEETING. An applicant's intent to rehabilitate a specific property should be discussed, at the earliest possible date, in a preliminary meeting (either by telephone or in person) with the building department. The applicant should specify the property's proposed use and occupancy, and describe the proposed rehabilitation work to be done. The building official should provide the applicant with information concerning code requirements, mandatory inspections, and permit fee schedules. In addition, the building official should provide information about the forms and applications that must be obtained from other community bodies such as the planning commission, the zoning board, the design review board, the landmarks commission, etc.

Based on the preliminary meeting, the building official must make one of three findings:

- no permit is required for the work to be done
- a permit is required, and sufficient information exists for a permit application to be made via the usual process (STEP D)
- a permit is required, but more information is required prior to permit application (STEPS B and C)

STEP B

DETERMINE THE STATUS OF THE EXISTING BUILDING. When more information is necessary, it can be obtained in one or both of the following ways:

1) Field survey. This survey should be conducted jointly by the applicant and the building official, and may include:
   - determination of structural integrity, measurement of height and area, assessment of egress and fire resistance, and identification of visible structural and other hazardous conditions
   - determination of serviceability and safety by means of load and sprinkler tests, or the removal of selected materials and equipment for system tests

   An exploratory permit may be required for testing, or for the removal of selected materials, components, or equipment for system tests. If such a permit is required, see Note 2.

2) Examination of building documents. Building documents, records, and drawings can yield substantial information about the building's structure and original construction. The applicant and the building official should carefully review all such documentation that may be available.

STEP C

MEET TO AGREE ON REQUIREMENTS. Based on the information established in STEP B, the applicant and the building official must meet to agree on the code-related requirements that will be applied to the rehabilitation project. This will include the following:

1) Scope of Work. Agreement should be reached regarding specific corrections required to meet code requirements, alternative methods for meeting the intent of the code, acceptance of existing situations not in conformance with the code, and recognition of any situations that will necessitate a formal appeals process.

2) Required Permits. The applicant may be required to apply for separate plumbing, electrical, elevator, gas fitting, etc., permits. In this event, the building official should provide information on the permits required, their cost, and how to apply for them.

3) Work Documentation. The applicant must be responsible for, at minimum, a work write-up consisting of a description of the work to be undertaken.

For larger rehabilitation projects, one or more of the following may be necessary:

- engineering calculations
- construction and "as built" drawings
- test data

Since documentation of the many hidden components of existing buildings is frequently impossible, the documentation requirements for rehabilitation are usually less stringent than those required for new construction.

STEP D

APPLICATION FOR PERMIT. The following steps are common to both new construction and rehabilitation. Depending on the decisions made in the preapplication phase, any one of the following types of permits may be sought:

1) Full permit. When there is sufficient information about the total scope of work, a full permit application may be filed.

2) Conditional permit. When there is insufficient information about an aspect of the total scope of work, a conditional permit may be applied for. Once conditions are met and verified by inspection, permit restrictions will be removed.

3) Partial permit. When the amount of information is insufficient for application for a full permit, but sufficient information exists for a segregable portion of the work (such as roof repair or replacement), a permit application for that part of the work may be filed. Additional partial permits may be requested at later stages of construction, and the partial permits may in the aggregate serve as a full permit.

NOTE: All work must proceed at the applicant's risk under conditional and partial permits.

STEP E

APPLICATION REVIEW. The permit application is reviewed by the building department and any other agency with jurisdiction (such as the zoning board). Two results are possible:

- Approval of the Application
- Rejection of the Application. The applicant may reapply, making necessary changes; he may appeal; or he may decide not to pursue the permit process (see Note 1).

STEP F

ISSUANCE OF THE PERMIT. The permit is issued and construction may begin to the extent the permit allows. The building official must notify the applicant when inspections will be conducted and what work will be inspected

STEP G

CONSTRUCTION INSPECTIONS. The field inspection process for rehabilitation should follow new construction procedures, with a series of inspections during construction and a final inspection upon completion. The inspections should be conducted by building inspectors or by specialty trade inspectors for specific work components such as electrical or plumbing. The timing of inspections falls into tow categories:

- Called inspection. The rehabilitator calls for an inspection at predetermined points in the construction process.
- Drop-in inspection. This inspection is not necessarily based on the construction schedule. Instead it is based on the schedule the inspector must keep to cover his work load.

For rehabilitation projects, field inspectors should carry a copy of the requirements jointly agreed to by the building department and the rehabilitator (see Step C). This may prevent unnecessary problems and misunderstandings between both parties during field inspections (see Note 1).

STEP H

FINAL INSPECTION AND CERTIFICATE OF OCCUPANCY. Upon completion of construction, the building department conducts a final inspection of the building. If compliance with requirements has been met, the building department issues a certificate of occupancy. For large or complex rehabilitation projects, and those where alternative code solutions were permitted, pertinent drawings, records, and agreements should be made a part of the building department's official records.

STEP I

MAINTENANCE INSPECTIONS AND PERIODIC INSPECTIONS. Maintenance and periodic inspection should be conducted in accordance with existing community ordinances, regulations, and codes.

Note 1

REJECTION OF PERMIT APPLICATION AND FIELD DISPUTES

When application for permit is rejected by the building department, or when field inspection disputes arise, the applicant may choose either of the following alternatives:

1) Revise the Rehabilitation Project's Scope-of-Work. Revision of the scope-of-work can be accomplished by repeating STEPS B and C. The building official and the applicant may discuss alternatives to meet requirements under dispute. Upon agreement by both parties, the applicant may reapply for a permit.

2) Appeals Board. If a revision to the scope-of-work is not acceptable to the applicant, the applicant may choose to appeal to the appellate body. The appellate body may grant the appeal, not grant the appeal, or provide alternate solution(s).

Note 2

EXPLORATORY PERMIT

An exploratory permit may be used to allow concealed construction or equipment to be exposed for inspection. With the information gained from such an inspection, the applicant and the building department can better complete STEP B. Exploratory permits should normally be necessary for large or complex rehabilitation projects where the amount of work necessary to expose concealed construction is extensive or poses a potential hazard.

CHAPTER 3

STATUTORY GUIDELINE

FOR

BUILDING REHABILITATION

INTRODUCTION

The authority to administer and enforce building-related codes is derived from statutes enacted by state and local legislative bodies. Normally these statutes determine the goals which are to be accomplished and establish the offices to carry out these goals. There currently exists a wide variety of code decision making systems for achieving statutory goals. This guideline provides recommendations for modifying existing code decision making systems with the express goal of promoting rehabilitation.

CODE DECISION MAKING FUNCTIONS

An analysis of code decision making systems reveals that they incorporate five general decision making functions. These functions, with associated recommendations, are explained as follows:

1. Basic Policy Making. Basic policy making for building-related codes is primarily the domain of state and local legislative bodies. Legislatures set basic policy goals. They authorize the adoption, revision, and integration of general codes related to building, housing, maintenance, health, and hazard abatement, as well as specialized codes for electrical, plumbing, mechanical, fire and life safety, architectural barriers, and energy, among others. Legislatures also create the rulemaking, enforcement, appeals, and advisory bodies needed to carry out the code regulatory process. These bodies may be assigned policy making functions of their own, including:

   - promulgating rules, regulations, and procedures
   - monitoring and evaluating code effectiveness and application
   - making legislative recommendations
   - providing technical advice or judgmental determinations

   The following basic policy making recommendations should be adopted to promote building rehabilitation:

   Recommendation 1. *Provide a Statement of Purpose that includes Rehabilitation*
   Recommendation 2. *Create a Rehabilitation Advisory Board*
   Recommendation 3. *Emphasize Rehabilitation Expertise in Code Rulemaking and Appellate Bodies*

2. Code Revision. Code revision involves the ongoing review and amendment of building-related requirements and standards. In statewide building codes, revisions are most commonly made by an independent rulemaking body - such as a state building code commission - through powers conferred by the legislature. In municipalities, a similar procedure may be followed, or the municipal legislature may itself enact code revisions.

   The following code revision recommendation should be adopted to promote building rehabilitation:

   Recommendation 4. *Establish Procedures for Determining the Impact of Code Revisions on Building Rehabilitation*

3. Administration and Enforcement. Code administration and enforcement consists primarily of plan or work reviews, permit issuance, and field inspections. These functions are largely carried out at the local level by one or more departments within a jurisdiction. Administration and enforcement also implies the following activities:

   - management, supervision, and training of personnel
   - record keeping and documentation
   - development of inspection manuals and related publications
   - initiation of studies, evaluations, and assessments
   - coordination of work with other departments or agencies

   The following administration and enforcement recommendations should be adopted to promote building rehabilitation:

   Recommendation 5. *Mandate Administrative Innovation for Rehabilitation*

4. Special Applications. Codes normally define the regulatory areas that require judgement by the enforcement body in lieu of specific prescriptive provisions. Building codes make allowance for the following kinds of these "special provisions" that may be of value in increasing the discretionary powers of code enforcement bodies:

   - modifications to structural, mechanical, or other provisions when practical difficulties dictate
   - alternate materials, equipment, and methods of construction not described in specific code provisions
   - change in building occupancy or use
   - additions, alterations, and repairs with a value below a specified percentage of building replacement or other cost
   - buildings of special historical or architectural significance

   Other discretionary powers may be given to the enforcement body by the legislature, with the general limitation that such powers be used consistent with the health and safety purposes of the codes involved.

These special applications are discussed in depth in the Guideline for Setting and Adopting Standards for Building Rehabilitation.

Official liability involved in the use of the discretionary powers allowed by these special applications is the subject of the Guideline for Managing Official Liability Associated with Building Rehabilitation.

5. Appellate Review. Appellate review is the process whereby an aggrieved party may appeal a decision by the code enforcement body. Building and related codes normally provide for an appellate board of some kind; for those that don't, appeals may be made to a judicial body. While appellate review is meant to be a second level dispute resolution by an impartial party, it may also be used to grant variances where the code enforcement body is not empowered to do so. When appellate decisions are written and publicly available, they can serve as a source of guidance for subsequent decisions and as an indicator of possible code revision needs.

The following appellate recommendations should be adopted to promote building rehabilitation.

Recommendation 6. Provide for Rehabilitation Variances by the Appellate Body

Recommendation 7. Evaluate Other Conditions Affecting Appeals

RECOMMENDATIONS

Recommendation 1

Provide a Statement of Purpose that Includes Rehabilitation

Legislative bodies articulate their fundamental policy goals in either the statement of purpose of a code, or code enabling legislation. Although statements of purpose may be considered unimportant to the substance of the legislation, they provide the basic policy expression to which other decision-making bodies - rulemaking, enforcement, appellate, and advisory - must frequently turn to resolve difficult questions. The following language gives a broad expression of support to rehabilitation:

"The (legislative body) finds that the public health, safety, and welfare is in part dependent on the conservation, rehabilitation, and reuse of the existing building stock, including both residential and other buildings; that the application of new construction requirements and standards to the rehabilitation of existing buildings unnecessarily increases the cost thereof; that adequate enforcement of minimum housing and other standards for safe and decent human habitation requires expeditious and cost-effective procedures for encouraging the rehabilitation of existing buildings; that rehabilitation is a major mechanism for increasing the health and safety in existing buildings; and that adequate resources in the form of public and private initiatives exist to increase and expand the incidence of rehabilitation when such rehabilitation is free of unreasonable regulatory restraint."

"It is therefore the purpose of this Code, to the maximum extent consistent with basic standards of human health and safety -

"(1) to promote the rehabilitation of existing sound buildings by allowing for differences between rehabilitation and new construction in the application of the requirements and standards of this code;

"(2) to encourage in rehabilitation the utilization of innovative and economical materials and methods of construction; and,

"(3) to encourage the agencies charged with enforcement of this code, and the officers thereof,
"(i) to apply the provisions of this code to rehabilitated buildings in a manner

consistent with the purposes stated herein; and,
"(ii) to exercise discretion and employ resourcefulness in the evaluation of code compliance of rehabilitated structures, in a manner consistent with the purposes stated herein."

Recommendation 2

Create a Rehabilitation Advisory Board

A specialized technical advisory board with experience and expertise in the problems of rehabilitation can provide significant help to the decision-making burdens of the legislative, rulemaking, appellate, and enforcement bodies. Such an advisory board can supply key advice on policies and activities that affect all phases of building rehabilitation. The following language may be used to create such an advisory board:

"The (legislative, rulemaking, or enforcement body) shall establish and periodically consult with a Rehabilitation Advisory Board (and other such advisory groups as may be deemed desirable) in the execution of its responsibilities under this (code). The Rehabilitation Advisory Board shall consist of no fewer than five (5) members, appointed by (appropriate person) for a term of (2) years, each of whom shall have experience and/or expertise in the rehabilitation of existing buildings and structures. The Rehabilitation Advisory Board shall provide advice and consultation to (legislative, rulemaking, enforcement, and appellate bodies) on all substantive decisions and actions that influence or otherwise affect rehabilitation within (name of jurisdiction)."

Recommendation 3

Emphasize Rehabilitation Expertise in Code Rulemaking and Appellate Bodies

Background qualifications and professional expertise are common requirements for members of code rulemaking, enforcement, appellate, and advisory bodies. Their obvious purpose is to assure that the necessary expertise is brought to bear by key advisory and decision-making personnel. In addition to the usual requirements for professional engineers, registered architects, skilled tradesmen, and the like, persons with rehabilitation experience and expertise should be included in rulemaking and appellate bodies. This may be statutorily required, as follows:

"For (rulemaking and appellate bodies), appoint one or more members that shall be persons of recognized ability and experience in the problems of, and practice incidental to, the rehabilitation of existing buildings."

Recommendation 4

Establish Procedures for Determining the Impact of Code Revisions on Building Rehabilitation

It is particularly important that new and existing code requirements and standards be assessed to determine their impact on the rehabilitation process. Language requiring this of a rulemaking, enforcement, or advisory body should stress the reporting of its findings:

"The (rulemaking, enforcement, or advisory body) shall monitor and evaluate, on an ongoing basis, the effectiveness and application of the provisions of (code or codes) and any rules, regulations, or procedures promulgated thereunder, to determine their impact on the rehabilitation of existing buildings. Pursuant to this responsibility, the (rulemaking, enforcement, or advisory body) shall gather information, conduct studies, and make (in consultation with the Rehabilitation Advisory Board) appropriate reports and recommendations related to the application of these provisions, the decisions of the (appellate body), and the experience of other jurisdictions."

Recommendation 5

Mandate Administrative Innovation for Rehabilitation

Successful approaches to rehabilitation may be heavily dependent on the day-to-day details of processing, inspection, and personnel management. Administrative streamlining can reduce rehabilitation processing time; special training programs can familiarize personnel with the unique problems of rehabilitation; and field inspection manuals can describe procedures for efficiently addressing local rehabilitation problems. These administrative devices may significantly lower rehabilitation entry barriers and costs, provided that the time, budget, and human resources are made available to develop and implement them.

Using one or more of the following clauses, a legislative body can require a code enforcement agency to:

- *"initiate a separate submittal/approval process for rehabilitation projects"**
- *"coordinate, with (appropriate agencies or departments), the development of specialized permit, inspection, and related administrative programs that encourage rehabilitation"*
- *"establish special training programs in rehabilitation for building inspectors, permit review personnel, and other staff specialists"*
- *"create and publish field inspection manuals, guidelines, and other publications to describe the applicability of (code or codes) to the rehabilitation of existing buildings, and to the administration of such codes"*
- *"initiate a special rehabilitation office to answer rehabilitation inquiries, provide information on Federal and other assistance programs, and perform related duties"*
- *"initiate on outreach program to encourage building rehabilitation"**
- *"appoint a Chief of Building Rehabilitation and/or rehabilitation specialists to coordinate and/or perform rehabilitation inspections and grant permit approvals"*

* see Guideline for the Municipal Approval of Building Rehabilitation

Recommendation 6

Provide for Rehabilitation Variances by the Appellate Body

The appeals section of the code should contain an unequivocal statement allowing the appellate body to vary or modify code requirements that are impractical or that create financial hardship in rehabilitation projects. Language for such a statement is as follows:

"For the rehabilitation of existing buildings, the (appellate body) may vary or modify, in whole or in part, the application of any provision of this code where compliance with such provision creates practical difficulty or undue financial hardship. Such variance or modification shall be consistent with the purpose of this code to achieve acceptable levels of safety and to promote the conservation, rehabilitation, and reuse of the existing building stock."

Recommendation 7

Evaluate Other Conditions Affecting Appeals

Successful rehabilitation project appeals also depend on the following conditions external to the appeals section of the code:

- that the legislative purpose of the code clearly recognizes rehabilitation as a public policy goal (see Recommendation 1)
- that persons with expertise in rehabilitation are members of the appellate body (see Recommendation 3)
- that the code clearly states that the rehabilitation of existing buildings be treated differently from new construction (see Recommendation 1)
- that appellate procedures are not unduly costly or time consuming, or do not otherwise provide disincentives, especially to small rehabilitation projects
- that appellate decisions are made in writing for use as precedent in later cases
- that any person aggrieved by a decision of the code enforcement body should be entitled to appeal

CHAPTER 4

GUIDELINE FOR MANAGING OFFICIAL LIABILITY ASSOCIATED WITH BUILDING REHABILITATION

INTRODUCTION

The successful rehabilitation of buildings constructed prior to the enactment of existing building codes requires approaches that achieve code purposes (such as adequate ventilation) within the restraints (such as existing windows) imposed by the architectural characteristics that make the structure worth rehabilitating. Even where the law grants to governments and their officials the authority to act with discretion and to seek new solutions to code requirements, the fear of liability for decisions that may result in the death or injury of an occupant of the rehabilitated building chills the willingness of those governments and officials to apply building codes with latitude sufficient to permit successful rehabilitation. Although courts have only rarely imposed liability upon code enforcement agencies or their officials for conduct related to building code enforcement, the scope of governmental liability to private citizens has generally increased, creating uncertainty and anxiety among individual code officials. In light of the trend of increasing liability, the mere threat of litigation, and the time, expense, and injury to professional reputation that accompanies even the groundless suit, inhibits needed creativity in code interpretation and enforcement.

PROBLEMS AND RECOMMENDATIONS

1. General Immunities for Government Employees

Problem: The liability of state and municipal employees is unclear in many states, and undue conservatism in code enforcement results from the code official's uncertainty of his legal status.

Discussion: In approximately half the states of the United States the liability of state and/or municipal employees is unclear. Often, state statutes abrogating governmental immunities overlook the personal liability of governmental employees. When such an omission occurs, courts presented with the issue must guess the legislature's intent, and the results have been inconsistent. In many jurisdictions without relevant statutes, there are no court decisions of recent enough vintage to provide guidance to the individual employee.

To fill this vacuum, statutes should be enacted addressing government employee liability (or immunity) for negligent actions. They can be drafted to provide protection for code enforcement functions pertinent to rehabilitation without singling out building code enforcement for special treatment.

Recommendations:

1.1 States should grant state and municipal employees immunity from liability for negligence arising from one of the following:

1.1.1 all their activities within the scope of their authority. The following language is based on Conn. Gen. Stat. Ann. 4-165. The second sentence is appropriate only in those jurisdictions that have waived governmental immunity:

"No (state/municipal) officer or employee shall be personally liable for damage or injury, not wanton or wilful, caused in the performance of his duties and within the scope of his employment. Any person having a complaint for such damage or injury shall present it as a claim against the (state/municipality) under the provisions of (applicable state or municipal law)."

1.1.2 their discretionary activities within the scope of their authority. The following language is based on Cal. Gov. Code §820.2. The phrase "except as otherwise provided by statute" allows for specific exceptions, such as absolute immunity for high-ranking officials:

"Except as otherwise provided by statute, a public employee is not liable for an injury resulting from his act or omission where the act or omission was the result of the exercise of the discretion vested in him, whether or not such discretion be abused."

1.2 In the absence of state action, municipalities should enact provisions granting the same immunities. In each case, the municipality must first ascertain that it has the legal authority to immunize its employees from state tort law. An example of such an enactment is the following Wilmington, Del. ordinance, 2 Wilm. C. §34-7:

"No member, officer or agent of the Department of Licenses and Inspections shall be sued or held to liability for any act done or omitted in good faith and with ordinary discretion on behalf of or under such Department, or pursuant to the Charter of the City, or any statutes, ordinances or rules and regulations under which such Department has authority to act."

1.3 States and local jurisdictions should consider indemnifying their employees for the expenses of defending against lawsuits arising out of their work, and for the payment of judgments handed down against them in such lawsuits. Indemnification can be required by statute, with the use of the following language:

"All officers and employees of (the state, or local jurisdiction, as applicable) charged with enforcement of (state or municipal law generally, or, specifically enumerated laws such as building codes) shall be relieved of all personal liability for all damage that may accrue to persons or property, and for all costs, including attorney's fees, reasonably necessary to defend against litigation resulting from any act required or permitted in the discharge of official duties and exercised in good faith without malice or intentional wrongdoing. Pursuant to this section, the (jurisdiction) may purchase insurance to indemnify itself, its officers, and its employees, from legal liability and defense costs. If insurance is not purchased or available, a suit instituted against an officer or employee for conduct arising out of the lawful discharge of official duties shall be defended by the (legal representative of the jurisdiction, e.g., city attorney) until the final termination of the proceedings, and the (jurisdiction) shall be liable for all costs reasonably necessary to defend such action and for all resulting judgments against the officers and employees based on the good faith discharge of said official duties."

1.4 States or local jurisdictions that indemnify their employees usually purchase insurance for that purpose. In a small number of states, such purchase of insurance operates as a waiver of immunity. Therefore, the effect of purchasing insurance should be thoroughly investigated by appropriate legal counsel prior to its purchase.

1.5 States and local jurisdictions should avoid placing their employees in the position where the employee's liability is greater than that of the government for which he works. In such cases, the employee will be the sole target of any lawsuit, and the inhibiting effect of that exposure may be excessive and damaging to rehabilitation.

2. Specific Immunities for Code Enforcement Activities

Problem: In a large number of states, it is virtually impossible to tell whether negligent code enforcement activities give rise to individual liability, because it is unclear whether various protections given to code enforcement remain.

Discussion: A large number of states, perhaps the majority, may retain the common law rule known as the Public Duty Doctrine, which has generally prevented liability from being imposed on officials for any code enforcement function. But recent statutory abrogations of immunities in many states have left the vitality of the court-made doctrine in question. The doctrine itself, which provides immunity for acts performed in the course of a duty owed only to the public generally (rather than to a specific individual), is highly unpredictable in its effect on specific cases. Courts in Washington and Oregon have found exceptions to the rule and have imposed liability for negligent code enforcement; Alaska rejected the rule altogether for code enforcement.

Similarly, a legal doctrine - sometimes judicial, sometimes statutory - that provides immunity for all "governmental functions" has been held to immunize code enforcement officers. But it, too, is on the wane, and has been discarded in a number of jurisdictions.

A more stable and predictable means of immunizing code officials is needed.

Recommendations:

2.1 States (and those municipalities with the legal authority to do so) should consider fully immunizing themselves, their subdivisions, and all public employees, from liability for negligence in code enforcement functions. The immunization would take the form of a specific statutory reservation of immunity for negligent inspection, negligent failure to inspect, negligent failure to enforce discovered violations, and negligent issuance or denial of permits.

Nine states have enacted such specific reservations of immunity, with some variation in their scope. They are California, Illinois, Indiana, Miane, Nevada, New Jersey, Oklahoma, Tennessee, and Utah.

None of these statutes has been declared invalid in court, but the issuance of a permit to an applicant who had failed to obtain statutorily required insurance created liability in California and in Oregon despite the existence of immunizing statutes in both states.

The following language is based on Cal. Gov. Code §§818.2, 818.4, and 818.6 (2.1.1, 2.1.2, and 2.1.3, respectively - governmental immunity); §§821.2, and 821.4 (2.1.4, 2.1.5, and 2.1.6, respectively - personal immunity):

2.1.1 *"A public entity is not liable for an injury caused by adopting or failing to adopt an enactment or by failing to enforce any law."*

2.1.2 *"A public entity is not liable for an injury caused by the issuance, denial, suspension or revocation of, or by the failure or refusal to issue, deny, suspend or revoke, any permit, license, certificate, approval, order, or similar authorization where the public entity or an employee of the public entity is authorized by enactment to determine whether or not such authorization should be issued, denied, suspended or revoked."*

2.1.3 *"A public entity is not liable for injury caused by its failure to make an inspection, or by reason of making an inadequate or negligent inspection, of any property, other than its property (refer to statutory definition, if any), for the purpose of determining whether the property complies with or violates any enactment or contains or constitutes a hazard to health or safety."*

2.1.4 *"A public employee is not liable for an injury caused by his adoption of, or failure to adopt, an enactment, or by his failure to enforce an enactment."*

2.1.5 *"A public employee is not liable for an injury caused by his issuance, denial, suspension or revocation of, or by his failure or refusal to issue, deny, suspend, or revoke, any permit, license, certificate, approval, order, or similar authorization where he is authorized by enactment to determine whether or not such authorization should be issued, denied, suspended or revoked."*

2.1.6 *"A public employee is not liable for injury caused by his failure to make an inspection, or by reason of making an inadequate or negligent inspection, of any property, other than the property of the public entity employing the public employee (with reference to statutory definition of such property, if such definition exists), for the purpose of determining whether the property complies with or violates any enactment or contains or constitutes a hazard to health or safety."*

3. Immunities for Elements of Code Enforcement Requiring the Exercise of Discretion

Problem: In jurisdictions granting immunity only for activities requiring the exercise of discretion, the extent to which code officials are liable is unclear, and liability may be unjustly imposed.

Discussion: A number of jurisdictions that have made their employees liable for negligence have nevertheless preserved employee immunity for functions that require the exercise of discretion. Of course, every act requires some discretion, and the courts have attempted to lend predictability to their decisions by drawing distinctions between the "planning" and "operational" levels, between "policy making" and "execution," and between "high" and "low" officers. The treatment the courts have given to various code enforcement functions has been mixed, and none of the foregoing approaches has decreased the level of uncertainty that is the source of the code official's fears.

The code enforcement activities most important to successful rehabilitation all involve the weighing of alternatives and the balancing of competing policies. The recommendations in this section attempt to relieve the uncertainty of code officials by ensuring that their discretionary activities will be treated as such in jurisdictions in which those functions are immune from liability.

Recommendations:

3.1 Building-related codes should include provisions emphasizing the elements of code enforcement that require the exercise of discretion. Such should include:

3.1.1 provisions spelling out the need for code officials to select from among competing compliance alternatives.

3.1.2 use of the work "discretion" in appropriate provisions, even though "waiver," "variance," and modification implicitly connote discretion.

3.1.3 statements of purpose emphasizing that rehabilitation is a goal of the code enforcement system, noting the discretion required of code officials if that goal is to be achieved.[1]

3.2 In consultation with appropriate state or municipal counsel, code enforcement agencies should develop recordkeeping systems that will demonstrate to judges and juries the degree and reasonableness of discretion exercised in code enforcement, particularly in the inspection and approval of rehabilitated buildings. Where practical, the records should show the manner in which competing interests are weighed in order to reach decisions in specific cases.

4. Reducing the Fear of Liability by Improving Agency Practices

Problem: Operating procedures of code enforcement agencies may inadequately provide the support services necessary to permit officials to deal confidently with the special problems of rehabilitation, thereby heightening individual fears of the liability that may result from a mistake in judgment.

Discussion: Even in jurisdictions that hold code enforcement officials liable for their negligence, that liability - and fear of it - can be substantially reduced by agency practices that prevent the official from acting negligently.

Those practices can involve the official directly by improving his training and by providing him with better field guidance. They can provide experts to whom the official can turn for advice in novel situations. If an official is sued, improved agency recordkeeping practices can protect him from lapses in memory, personnel turnover in the agency, and the court's temptation to substitute its judgment for his. The very existence of improved management practices can to a great degree prevent the filing of weak or frivolous lawsuits.

In reducing the potential for negligent conduct, the government can also reduce the number of people injured by official negligence. In doing so, it can give code officials a new confidence that their activities are not - and will not be found - negligent, thereby encouraging latitude in official acceptance of novel solutions to the special code enforcement problems posed by rehabilitation.

Recommendations:

4.1 Develop, distribute, and require the use of detailed manuals for field personnel.[2]

4.2 Improve the training of field personnel, particularly with respect to rehabilitation.[2]

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[1] See STATUTORY GUIDELINE FOR BUILDING REHABILITATION, Recommendation 1.

[2] See also, STATUTORY GUIDELINE FOR BUILDING REHABILITATION, Recommendation 5.

4.3 Improve the supervision of field personnel, not only from the standpoint of greater discipline, but also by making supervisors available to assist in approaching the problems of rehabilitation. This may in turn require continuing training and education for supervisors to increase their sophistication in dealing with rehabilitation.[1]

[1] See also, STATUTORY GUIDELINE FOR BUILDING REHABILITATION Recommendation 5.

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APPENDIX 1

High-Rise Requirements Adopted by
The California State Fire Marshal

(5) Amend Section 21.33, to read:

21.33. Existing High-Rise Buildings. Section B2133, Part 2, Title 24, CAC, is hereby adopted as a part of these regulations and reads:

B2133. Existing High-Rise Buildings. For requirements relating to existing high-rise buildings of Type IV construction see Section B1733 through Section B1747.

(6) Amend Section 22.33, to read:

22.33. Existing High-Rise Buildings. Section B2233, Part 2 Title 24, CAC, is hearby adopted as part of these regulations and reads:

B2233. Existing High-Rise Buildings. For requirements relating to existing high-rise buildings of Type V construction, see Section B1733 through Section B1747.

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These regulations will not cause a fiscal impact on any local agency or school district and will not therefore be a financial responsibility of the State pursuant to Section 2231 of the Revenue and Taxation Code.

(1) Assignment of a responsible person as Fire Safety Director to work with the fire authority in the establishment, implementation and maintenance of the emergency pre-fire plan.

(2) The telephone number of the local fire department shall be conspicuously posted in a location adjacent to the telephone in each dwelling unit, hotel guest room, telephone switchboard, and in other areas as directed by the fire authority having jurisdiction.

(3) Emergency plan procedures shall be conspicuously posted in each dwelling unit, hotel guest room, office area, and other locations as required by the fire authority having jurisdiction. Such procedures shall provide for the relocation or evacuation of building occupants.

(g) Compliance Date. Except as may be otherwise specified, existing high-rise buildings shall conform to the applicable requirements of these regulations by April 26, 1979.

(2) Amend Section 18.33, to read:

18.33. Existing High-Rise Buildings. Section B1833, Part 2, Title 24, CAC, is hereby adopted as a part of these regulations and reads:

B1833. Existing High-Rise Buildings. For requirements relating to existing high-rise buildings of Type I construction, See Section B1733 through Section B1747.

(3) Amend Section 19.33, to read:

19.33. Existing High-Rise Buildings. Section B1933, Part 2, Title 24, CAC, is hereby adopted as part of these regulations and reads:

B1833. Existing High-Rise Buildings. For requirements relating to existing high-rise buildings of Type II construction, see Section B1733 through B1747.

(b) Amend Section 20.33, to read:

20.33. Existing High-Rise Buildings. Section B2033, Part 2, Title 24, CAC, is hereby adopted as a part of these regulations and reads:

B2033. Existing High-Rise Buildings. For requirements relating to existing high-rise buildings of Type III construction, see Section B1733 through Section B1747.

Note: The foregoing quoted Sections B1733 Through B1747 have been taken from Title 24, California Administrative Code. The following subsections (b) through (g) are non-building standards and are contained only in Title 19, California Administrative Code under section 17.33.

(b) Fire Hazards. No person shall permit any fire hazard to exist on premises under his or her control, or fail to take immediate action to abate a fire hazard when required by the enforcing agency.

"Fire Hazard" as used in this section means any condition, arrangement, or act which will increase, or may cause an increase of, the hazard or menace of fire to life safety to a degree greater than customarily recognized as normal by persons in the public service of preventing, suppressing or extinguishing fire.

(c) Plans and Specifications. (1) Complete plans or specifications, or both, shall be prepared covering all work required pursuant to this section. Such plans or specifications shall be submitted to the enforcing agency having jurisdiction.

(2) When new construction is required to conform with the provisions, of these regulations, complete plans or specifications, or both, shall be prepared in accordance with the new provisions of this subsection. As used in this section "new construction" is not intended to include repairs, replacements or minor alterations which do not disrupt or appreciably add to or affect the structural aspects of the building.

(d) Flammable Liquids. The storage, handling and use of flammable liquids shall be in accordance with provisions of the Uniform Fire Code, 1973 Edition, as published by the Western Fire Chief's Association and the International Conference of Building Officials.

(e) Maintenance. All fire alarm, fire detection, automatic sprinkler systems, communication systems, and all other items or systems required by this section shall be maintained in an operable condition at all times. Upon disruption of any such system, immediate action shall be instituted to effect a reestablishment of such system to its normal operating condition.

(f) Emergency Pre-Fire Planning. Owners, Operators, tenants, administrators and managers of high-rise buildings shall in cooperation with the fire authority having jurisdiction, establish procedures which shall include but not necessarily be limited to the following:.

B1745. Exit Signs and Illumination. Exits and exitways shall be provided with exit signs and illumination as required by Section B3312.

Exception: When acceptable to the enforcing agency, approved self-illuminating exit signs and directional signs may be used.

B1746. Automatic Sprinkler Systems - Existing High-Rise Buildings. Regardless of any othe provisons of these regulations, every existing high-rise building of Type III-N, Type IV-N or Type V-N construction shall be provided with an approved automatic sprinkler system conforming to NFPA 13, 1974.

B1747. Group H Occupancies - Existing High-Rise Buildings. (a) General. Regardless of other provisions of these regulations relating to existing high-rise buildings, requirements relative to existing Group H Occupancy shall be not less restrictive than those established pursuant to Section 17920.7, Health and Safety Code. (See Chapter 13, Appendix UBC, 1970 Edition.)

(b) Exit Corridor Openings. Openings in corridor walls and ceilings shall be protected by not less than 1-3/4 inch solid bonded wood core doors, 1/4-inch thick wired glass conforming to Section 4306(h), UBC, by approved fire dampers conforming to SFM 43.2, or by equivalent protection in lieu of any of thse items. Transoms shall be fixed closed with material having a fire-resistive rating equal to 1/2 inch, type X gypsum wallboard or equivalent material installed on both sides of the opening.

(c) Fire Alarm Systems. Nonwithstanding the provisions of B1738, every existing Group H Occupancy shall have installed therein a fire alarm system conforming to this subsection.

(1) General. Every apartment house and every hotel shall have installed therein an automatic or manually operated fire alarm system. Such fire alarm systems shall be so designed that all occupants of the building may be warned simultaneously.

(2) Installation. The installation of all fire alarm equipment shall be in accordance with Part 3.

(3) Fire Extinguishing Systems. Automatic fire extinguishing system installed in any structure subject to these regulations shall have an approved flow indicator electrically interconnected to the required fire alarm system.

B1741. Interior Wall and Ceiling Finish. Interior wall and ceiling finish of exitways shall conform to the provisions of Chapter B42. Where the materials used in such finishes do not conform to the provisons of Chapter B42, such finishes may be surfaced with an approved fire-retardant coating.

Floor covering materials having a pile or nap shall not be used as an interior wall or ceiling finish.

B1742. Ventilation. Natural or mechanical ventilation for the removal of products of combustion shall be provided in every story of an existing high-rise building. Such ventilation shall be any one or combustion of the following:

(a) Panels or windows in the exterior wall which can be opened. Such venting facilities shall be provided at the rate of at least 20 square feet of opening per 50 lineal feet of exterior wall in each story, distributed around the perimeter at not more than 50 foot intervals on at least two sides of the building.

(b) Approved fixed tempered glass may be used in lieu of openable panels or windows. When only selected panels or windows are of tempered glass they shall be clearly identified as required by the enforcing agency.

(c) Any other design which will produce equivalent results.

B1743. Smoke Control Systems. Existing air circulation systems shall be provided with an override switch in a location approved by the enforcing agency which will allow for the manual control or shut-down of the systems.

Exception: Systems which serve only a single floor, or portion thereof, without any pentration by ducts or other means

into adjacent floors.

B1744. Sensing Devices - Elevators. Sensing devices for emergency operation of elevators shall be provided as required by Section 3041, Title 8, California Administrative Code.

Exception: Sensing devices required by Section B1744 shall be SFM approved and listed detectors of the type which respond to visible or invisible particles of combustion based upon a smoke obscuration of 0.03 optical density per foot or more at ceiling height or at an elevation of 12 feet, whichever is lower, at the elevator entrance.

(e) Systems Interconnection. When a automatic fire detection system or an automatic extinguishing system is installed, activation of such system shall automatically cause the sounding of the fire warning system signaling devices at locations designated by the enforcing agency.

(f) Manual Sending Stations. Except as provided in Section B1747(c), manual fire alarm stations shall be provided in the locations designated by the enforcing agency. Such locations, shall be where stations are readily accessible and visible and in normal paths of daily travel by occupants of the building but need not exceed that specified in Part 3 of the distribution of manual sending stations.

(g) Wiring. Approved and listed TFE cables may be installed exposed or concealed without the use of raceways. Such exposed cables shall not be installed less than seven feet from the floor and when passing through fire-resistive construction shall have their penetrations protected in such a manner as to retain the integrity of the fire-resistive construction.

Exception: Previously installed fire alarm wiring in good condition and adequate for the system's electrical requirements may be accepted.

B1739. Occupant Voice Notification System. An approved occupant voice notification system shall be provided in every existing high-rise building which exceeds 150 feet in height measured in the manner set forth in Section B1733. Such system shall provide communication from a location available to and designated by the enforcing agency to not less than all public areas.

The occupant voice notification system may be combined with a fire alarm system provided the combined system has been approved and listed by the State Fire Marshal. The sounding of a fire alarm signal in any given area or floor shall not prohibit voice communication to other areas or floors. Combination systems shall be designed to permit voice transmission to override the fire alarm signal shall not terminate in less than 3 minutes.

B1740. Fire Department System. When it is determined by test that portable fire department communication equipment is ineffective, a communication system acceptable to the enforcing agency shall be installed within the building to permit emergency communication between fire suppression personnel.

B1738. Fire Warning Systems. (a) General. Every existing high-rise building shall be provided with an approved fire warning system.

In department stores, retail sales stores, and similar occupancies, where the general public is admitted, such systems shall be of a type to alert staff and employees. In office buildings and all other high-rise

buildings, such systems shall be of a type capable of alerting all occupants simultaneously.

Exceptions: (1) In areas of public assemblage, the type and location of audible devices shall be as determined by the enforcing agency.

(2) When acceptable to the enforcing agency, the occupant voice notification system required by Section B1739 may be used in lieu of the fire warning system required by Section B1738.

(b) Existing Systems. Existing fire warning systems, when acceptable to the enforcing agency, shall be deemed as conforming to the provisions of these regulations. For requirements for existing Group H Occupancies, see Section B1747(c).

(c) Annunciation. When a new fire alarm system is installed, it shall be connected to an annunciator panel installed in a location by the enforcing agency.

For purposes of annunciation, zoning shall be in accordance with the following:

(A) When the system serves more than one building, each building shall be considered as a separate zone.

(B) Each floor shall be considered as a separate zone.

Exception: Selective coded systems need not conform to Sections (A) and (B).

(b) Fire Department Notificiation. There shall be provided a dependable method of notifying the fire department.

(c) Protection of Exterior Openings. When an existing fire escape is accepted as one of the required means of egress, openings onto the fire escape landing and openings within 5 feet horizontally of the landing shall be protected in a manner acceptable to the enforcing agency. (See Section B1733(d)).

(d) Locking of Stairway Doors. When exit doors from corridors to exit stairways are locked to prohibit access from the stairway side, conformance with Section B1807(j) shall be provided or, in lieu thereof, master keys which will unlock all such doors from the stairway side shall be provided in such numbers and locations as approved by the enforcing agency.

B1737. Vertical Shafts. (a) Enclosures. Interior vertical shafts, including but not limited to, elevator, stairway and utility shall be enclosed with construction as set forth in Section B1735.

(b) Opening Protection. Doors in other than elevators, which shall be of a type acceptable to the enforcing agency, shall be approved one-hour fire rated tight fitting or gasketed doors, or equivalent protection, and shall be of the normally closed type, self-closing, or of a type which will close automatically in accordance with Section 4306(b)(2).

Exception: In lieu of stairway enclosures, smoke barriers may be provided in such a manner that fire and smoke will not spread to other floors or otherwise impair exit facilities.

In these instances, smoke barriers shall be not less than one-hour fire resistive with openings protected by not less than approved 1/3-hour fire-rated tight fitting or gasketed doors. Such doors shall be of self-closing type or of a type which will close automatically

in the manner specified in Section 4306(b)(2). Doors crossing corridors shall be provided with wired glass vision panels set in approved steel frames.

Doors for elevators shall not be of the open grill type.

Note: It is the intent of this provision that existing wood frames may have their use continued.

(b) New Construction. All new construction shall be composed of materials and assemblies of materials conforming to the fire-resistive provisions of these regulations. In no case shall enclosure walls be required to be of more than one-hour fire-resistive construction.

Exception: When approved by the enforcing agency, materials specified Section B1735 (a) may be used for new construction when necessary to maintain continuity of design and measurement of existing construction.

B1736. Exits. (a) General. Every floor from an existing high-rise building shall have access to two separate means of egress, one of which, when approved by the enforcing agency, may be an existing exterior fire escape.

New installations of smoke proof enclosures shall not be required.

Note: In determining the adequacy of exits and their design, Chapter B33 may be used as a guide. It is the intent of this Section that every existing high-rise building need not mandatorily conform or be made to conform with the requirements for new high-rise buildings. Reasonable judgment in the application of requirements must be exercised by the enforcing agency.

(b) Fire Escapes. An existing fire escape in good structural condition may be acceptable as one of the required means of egress from each floor. Access to such fire escapes may be any one of the following:

(1) Through a room between the corridor and the fire escape if the door to the room is operable from the corridor side without the use of any key, special knowledge or effort.

(2) By a door openable to a fire escape from the interior without the use of any key, special knowledge or effort.

(3) By a window operable from the interior. Such window shall have a minimum dimension of 29 inches when open. The sill shall be not more than 30 inches above the floor and landing.

For the purpose of this section, construction shall be deemed to have commenced when plans and specifications are more than 50 pecent complete and have been presented to the local jurisdiction prior to July 1, 1978. Actual construction of such buildings shall commence on or before January 1, 1976, unless all provisions for new buildings have been met.

(b) Compliance Date. Except as may be otherwise specified, existing high-rise buildings shall conform to the applicable requirements of these regulations by April 26, 1979.

(c) Continued Use. Existing high-rise buildings may have their use continued if they conform, or are made to conform, to the intent of the provisions of Section B1734 through B1747 to provide for the safety of the occupants of the high-rise buildings and persons involved in fire suppression activities.

(d) Alternate Protection. In addition to the provisions of Section B306, alternate means of egress, fire resistive area separations, smoke barriers, automatic fire detection or fire extinguishing systems, or other fire protection devices, equipment or installations may be approved by

the enforcing agency to provide reasonable and adequate life safety as intended by Sections B1734 through B1747 for existing high-rise buildings.

B1734. General. Basic Provisions. The provisions outlined in Sections B1734 through B1747 are applicable to every existing high-rise building.

B1735. Construction. (a) Minimum Construction. Existing wood lath and plaster, existing 1/2-inch gypsum wallboard, existing installations of 1/4 inch thick wired glass which are or are rendered inoperative and fixed in a closed position, or other existing materials having similar fire-resistive capabilities shall be acceptable. All such assemblies shall be in good repair, free of any condition which would diminish their original fire-resistive characteristics.

Where 1-3/4 inch solid bonded wood core doors are specified in these regulations for existing high-rise buildings, new or existing 1-3/8 inch doors shall be acceptable where existing framing will not accommodate a 1-3/4 inch door.

(1) Amend Section 17.33, to read:

17.33. Existing High-Rise Buildings. (a) General. Existing high-rise buildings shall conform to the provisions of Section B1733 through Section B1747, Part 2, Title 24, CAC which are hereby adopted by reference, are printed in italics and read as follows:

B1733. Existing High-Rsie Buildings. (a) Scope and Definition. The provisions of Sections B1733 through B1747 shall apply to every existing high-rise building of any type of construction or occupancy having floors (as measured from the top of the floor surface) used for human occupancy located more than 75 feet above the lowest floor level having building access.

Exceptions: (1) Hospitals as defined in Section 1250 of the Health and Safety Code.

(2) Buildings owned by any local agency or school district.

(3) Buildings such as power plants, look-out towers, steeples, grain houses and similar structures with non-continuous human occupancy, when so determined by the enforcing agency.

For the purpose of this section, "building access" shall mean an exterior door opening conforming to all of the following:

(1) Suitable and available for fire department use.

(2) Located not more than 2 feet above the adjacent ground level. When located more than 2 feet above the adjacent ground level measurement shall be taken from the floor surface of the story or basement immediately below.

(3) Leading to a space, room or area having foor traffic communication capabilities with the remainder of the building.

(4) Designed to permit penetration through the use of fire department forcible entry tools and equipment unless other approved arrangements have been made with the enforcing agency having jurisdiction.

"Existing high-rise structure" means a high-rise structure, the construction of which is commenced or completed prior to July 1, 1974.

APPENDIX 2

City of Los Angeles Stairway Enclosure Requirements for Hotels, Apartments and Similar Residential Buildings Exceeding Two Stories in Height

Ordinance No. 142,713

An Ordinance amending the Los Angeles Municipal Code.

THE PEOPLE OF THE CITY OF LOS ANGELES

DO ORDAIN AS FOLLOWS:

Section 1. Section 91.0103 of the Los Angeles Municipal code is hereby amended by adding Subsection (p) thereto, said new subsection to read:

(p) Fire Safety in Existing Group H Occupancies.

1. Notification. Whenever the Department determines by inspection that a building does not conform to the minimum requirements of Section 91.1302 of this Code, it shall order that such building be repaired and modified so as to conform to such minimum requirements. The order shall be in writing and shall be served either personally of by certified or registered mail upon the owner as shown on the last equalized assessment roll and upon the person, if any, in real or apparent charge or control of the building.

The order shall specify in what manner the subject building fails to meet the minimum requirements of Section 91.1302 of this Code and shall direct that necessary corrections shall be made within four years after service therof.

2. Recordation. At the time that the Department serves the aforementioned order, the Superintendent of Building shall file with the Office of the County Recorder a certificate stating that the subject building does not meet the minimum fire safety requirements of Section 91.1302 of this Code, and that the owner thereof has been so notified.

After all necessary corrective work has been performed, the Superintendent of Building shall file with the Office of the County Recorder a certificate terminating the status of the subject building as nonconforming to the minimum fire safety requirements of Section 91.1302.

3. Enforcement. If the owner or other person in charge and control of the subject building fails to comply with the aforementioned order within four years, the Superintendent of Building shall order that the building be vacated and that the building remain vacated until all required corrective work has been completed. Whevever compliance with the correction order issued pursuant to the provisions of this subsection has not been accomplished with 90 days after the date the building has been ordered vacated, or such additional time as may have been granted by the Department or the Board, the Superintendent may order its demolition in accordance with the provisions of Subsection (o) of this Section.

Sec. 2. The Los Angeles Municipal Code is hereby amended by adding Section 91.1302 thereto, said new section to read:

SEC. 91.1302. FIRE SAFETY STANDARDS FOR EXISTING GROUP H OCCUPANCIES.

(a) Purpose. The purpose of this section is to provide a reasonable degree of fire safety for persons living and sleeping in apartment houses, hotels, and apartment hotels by requiring alterations to such existing buildings which do not conform to the minimum exiting, shaft enclosure and corridor protection requirements of this Code.

(b) Scope. The provisions of this section apply to all existing

buildings more than two stories in height which contain Group H Occupancies. The provisions of the section shall not authorize the modification of existing building or portions thereof which provide a greater degree of protection against fire than the minimum requirements established by this section.

(c) Corridor Walls and Openings. The walls of every public corridor shall be protected by one-hour fire resistive construction, provided however, that existing walls constructed of wood lath and plaster and which are in good condition, will be acceptable in lieu thereof.

Transoms and openings other than doors from public corridors to guest rooms and dwelling units shall be closed and solidly covered with material which will provide the same degree of fire resistiveness as shall be provided by adjacent corridor walls.

All door openings from public corridors to guest rooms and dwelling units shall provide the same degree of fire resistiveness as shall be provided by adjacent corridor walls.

(d) Shaft Enclosures. All stairwells shall be enclosed in an approved shaft enclosures, provided however, that existing enclosure walls constructed of wood lath and plaster which is in good condition will be accepted in lieu of approved shaft wall construction.

EXCEPTIONS:

1. In building erected prior to January 1, 1943, stairshaft enclosures may be omitted if all stairways, hallways, exitways and closet or storage areas adjacent thereto are sprinklered. No basement sprinklers will be required by reason of this exception where none exist if one-hour fire resistive partitions with 1 3/4 inch selfclosing solid core doors are provided so that a fire originating in the basement cannot spread directly to any adjoining floor or story. Portions of a building containing occupancies other than Group H Occupancies need not be sprinklered by reason of this exception provided all such portions are separated from the Group H Occupancies by conforming occupancy separation walls and floors.

2. In buildings erected prior to January 1, 1943, stairshaft enclosures may be omitted if one-hour fire resistive partitions with 1 3/4 inch self closing solid core doors are placed in all stairwell openings so that a fire originating on any floor or story cannot spread directly to any adjoining floor or story; and provided further that a low voltage fire warning system acceptable to the Fire Department is installed throughout the building in connection with the installation of fire resistive partitions.

(e) Existing Conditions.

1. Existing means of exit, including fire escapes, are acceptable where they exist in the required number and are maintained in good condition.

2. No standpipes will be required where none exists.

3. No emergency exitway illumination will be required where none exists.

4. Dead end corridors not over twenty feet in length may have access to a second exit through a stairshaft enclosure.

Sec. 3. Subsection (h) of Section 91.4912 of the Los Angeles Municipal Code is hereby amended by adding an exception thereto, said new exception to read:

EXCEPTION:

Emergency exitway illumination shall not be required in an apartment house or hotel erected for such use prior to

January 1, 1943.

Sec. 4. Subsection (a) of Section 91.4917 of the Los Angeles Municipal Code is hereby amended by repealing Exception 1 thereof.

Sec. 5. The exception to Subsection (a) of Section 91.4925 of the Los Angeles Municipal Code is hereby amended to read:

EXCEPTION:

Fire protection alarms, if nonexistent, shall not be required in an apartment house or hotel erected for such use prior to September 19, 1947, unless required to comply with the provisions of Section 91.1302 of this Code.

Sec. 6. Exception 1 of Subsection (a) of Section 91.4923 of the Los Angeles Municipal Code is hereby amended to read:

1. An automatic sprinkler system, if nonexistent, shall not be required in an apartment house or hotel erected for such use prior to September 19, 1947, unless such system is required by Section 91.1603 (g) of this Code or unless required to comply with the provisions of Section 91.1302 of this Code.

Sec. 7. The exception to Subsection (a) of Section 91.4926 of the Los Angeles Municipal Code is hereby amended to read:

Dry standpipes, if nonexistent, shall not be required in an apartment house or hotel erected for such use prior to January 1, 1943.

Sec. 8. The exception to Subsection B of Section 57.121.06 of the Los Angeles Municipal Code is hereby amended to read:

Fire alarm or fire warning systems, if nonexistent, shall not be required in habitational occupancies erected for such use prior to September 19, 1947, unless required to comply with the provisions of Section 91.1302 of this Code.

Sec. 9. The City Clerk shall certify to the passage of this ordinance and cause the same to be published in some daily newspaper printed and published in the City of Los Angeles.

I hereby certify that the foregoing ordinance was passed by the Council of the City of Los Angeles, at its meeting of November 9, 1971.

APPENDIX 3

City of Los Angeles Preliminary Draft of "Earthquake Hazard Reduction in Existing Buildings," Currently Being Considered for Adoption

PRELIMINARY DRAFT

AS APPROVED BY THE

EARTHQUAKE SAFETY STUDY COMMITTEE

November 9, 1978

DIVISION 68 — EARTHQUAKE HAZARD REDUCTION IN EXISTING BUILDINGS

SECTION 91.6801 PURPOSE:

The purpose of this Division is to promote public safety and welfare by reducing the risk of death or injury that may result from the effects of earthquakes on unreinforced masonry bearing wall buildings constructed before 1934. Such buildings have been widely recognized for their sustaining of life hazardous damage as a result of partial or complete collapse during past moderate to strong earthquakes.

The provisions of this Division are minimum standards for structural seismic resistance established primarily to reduce the risk of life loss or injury and will not necessarily prevent loss of life or injury or prevent earthquake damage to an existing building which complies with these standards. This Division shall not require existing electrical, plumbing, mechanical or fire safety systems to be altered unless they constitute a hazard to life or property.

This Division provides systematic procedures and standards for identification and classification of unreinforced masonry bearing wall buildings based on their present use.

Priorities and standards are also established under which these buildings are required to be structurally analyzed. Where the analysis or testing determines deficiencies, this Division requires the building to be strengthened or demolished.

SECTION 91.6802 SCOPE: The provisions of this Division shall apply to all existing buildings constructed or under construction prior to October 6, 1933, which on the effective date of this ordinance have unreinforced masonry bearing walls as defined herein.

EXCEPTION: This Division shall not apply to detached dwellings and detached apartment houses containing less than five dwelling units.

SECTION 91.6803 DEFINITIONS: For the purpose of this Division, certain terms are defined in Sections 91.2301, 91.2305 and as follows:

ESSENTIAL BUILDINGS: Those structures or buildings which are to be used for emergency purposes after an earthquake in order to preserve the peace, health and safety of the general public.

Such facilities shall include the following: hospitals and other medical facilities having surgery or emergency treatment areas; fire and police stations; municipal government disaster operation centers; and public utility and communication buildings deemed to be vital in emergencies.

HIGH RISK BUILDINGS: Any building, other than an essential building, having an occupant load as determined by Section 91.3301 (d) of 100 occupants or more, wherein the occupancy is used for its intended purpose for more than 20 hours per week.

EXCEPTION: High-risk buildings shall not include buildings having exterior walls braced with masonry cross walls or wood frame cross walls spaced less than

40 feet apart in each story.

LOW RISK BUILDINGS: Any building, other than an essential building, having an occupant load as determined by Section 91.3301 (d) of less than 20 occupants.

MEDIUM RISK BUILDINGS: Any building having an occupant load as determined by Section 91.3301 (d) of 20 occupants or more that is not classified as a high risk building or an essential building.

UNREINFORCED MASONRY BEARING WALL: A masonry wall having all of the following characteristics:

1. Provides the vertical support for a floor or roof.
2. The total superimposed load is over 100 pounds per linear foot.
3. The area of reinforcing steel is less than 50 percent of that required by Section 91.2418 (e) of this code.

SECTION 91.6804 RATING CLASSIFICATOINS:

(a) CLASSIFICATIONS: The rating classifications as exhibited in Table No. 68-A are hereby established and each building within the scope of this Division shall be placed in one such rating classification by the department. The total occupant load as determined by Section 91.3301 (d) of the entire building shall be used to determine the rating classification.

TABLE NO. 68-A
RATING CLASSIFICATIONS

TYPE OF BUILDING	CLASSIFICATION
Essential Buildings	I
High Risk Buildings	II
Medium Risk Buildings	III
Low Risk Buildings	IV

(b) MULTIPLE CLASSIFICATIONS. For the purpose of determining a Rating Classification, a building housing occupancies resulting in more than one rating classification shall be classified in the Rating Classification which is the most restrictive.

EXCEPTION: For the purposes of this Division, portions of buildings constructed to act independently when resisting seismic forces may be classed in separate rating classifications.

SECTION 91.6805 ADMINISTRATION:

(a) PRIORITY OF NOTIFICATION: Notification priorities for buildings within the scope of this Division shall be in accordance with the rating classifications determined for the buildings from Table No. 68-A. Buildings having a rating classification of I shall be notified first; buildings having a rating classification of II shall be notified second, but not earlier than six months after the effective date of this Division; buildings having a rating classification of III shall be notified third, but not earlier than 18 months after the effective date of this Division; and buildings having a rating classification of IV shall be notified last, but not earlier than five years after the effective date of this Division. Within each separate Rating Classification, the notification shall normally be based on the occupant load of the building, with the buildings housing larger occupant loads being notified first. The Department shall, upon receipt of a written request from the owner, order a building to comply with this Division prior to the normal notification date set forth in this Section.

(b) NOTIFICATION: Following the priorities listed in Subsection 91.6805 (a), the Department shall order the owner of each building within the scope of this Division to cause a structural analysis to be made of the building by a licensed civil or structural engineer or architect. If the building is found to be deficient in meeting the requirements of this Division, the owner shall cause

it to be structurally altered so as to conform to such requirements or be demolished.

The order shall be in writing and shall be served either personally or by certified or registered mail upon the owner as shown in the last equalized assessment roll, and upon the person, if any, in apparent charge or control of the building.

The order shall direct that the structural analysis and the structural strengthening plans, if required, be submitted to the Department for review within 270 days after service of the order. If the owner elects to demolish the building, a statement declaring an intention to demolish shall be submitted to the Department within 270 days after service of the order.

The order shall specify that permits required to demolish the building or accomplish the necessary structural alterations shall be obtained no later than one year after the service of the order, the necessary alterations or demolition must commence within 180 days of the date that the permit was issued and that the building be corrected to meet the minimum requirements of this Division or be demolished no later than three years after such service.

(c) APPEAL FROM ORDER: Within 180 days of the service of the order described in Subsection 91.6805 (b), the owner or person if any, in apparent charge or control of the building may appeal the Department's initial order and determination to the Board of Building and Safety Commissioners in accordance with procedures established in Section 98.0403 of the Los Angeles Municipal Code. Any such appeal shall be decided by the Board no later than 60 days after the date that the appeal is filed.

(d) RECORDATION: At the time that the Department serves the aforementioned order, the Superintendent of Building shall file with the Office of the County Recorder a certificate stating that the subject building is within the scope of Division 68, Earthquake Hazard Reduction in Existing Buildings -of the Los Angeles Municipal Code. The certificate shall also state that the owner thereof has been notified and has been ordered to structurally analyze the building and to structurally strengthen or demolish it where compliance within Division 68 is not exhibited.

If the building is either demolished, found not to be within the scope of this Division, or is structurally capable of resisting minimum seismic forces required by this Division as a result of structural alterations or an analysis, the Superintendent of Building shall file with the Office of the County Recorder a certificate terminating the status of the subject building as being classified within the scope of Division 68 - Earthquake Hazard Reduction in Existing Buildings in the Los Angeles Municipal Code.

(e) ENFORCEMENT: If the owner or other person in charge and control of the subject building fails to comply with the order within any of the time periods set forth in Section 91.6805 (b) the Superintendent of Building shall order that the entire building be vacated and that the building remain vacated until all required analysis and structural alterations have been completed. Whenever compliance with the aforementioned order issued pursuant to the provisions of this Division has not been accomplished within 90 days after the date the building has been ordered vacated, or such additional time as may have been granted by the Board, the Superintendent may order its demolition in accordance with the provisions of Section 91.0103 (o).

SECTION 91.6806 ANALYSIS AND DESIGN:

(a) GENERAL: Every structure within the scope of this Division

shall be analyzed and constructed to resist minimum total lateral seismic forces assumed to act nonconcurrently in the direction of each of the main axis of the structure in accordance with the following equation:

$$V = IKCSW \qquad (68\text{-}1)$$

The value of IKCS need not exceed the values set forth in Table No. 68-B based on the applicable rating classification of the building.

TABLE NO. 68-B
HORIZONTAL FORCE FACTORS BASED ON RATING CLASSIFICATION

RATING CLASSIFICATION	IKCS
I	0.186
II	0.133
III & IV	0.100

(b) LATERAL FORCES ON ELEMENTS OF STRUCTURES: Parts or portic of structures shall be analyzed and designed for lateral loads in accordance with Section 91.2305 (d), but need not be more than the value from the following equation:

$$F_p = IC_pSW_p \qquad (68\text{-}2)$$

For the provisions of this subsection, the product of IS need not exceed the values as set forth in Table No. 68-C.

EXCEPTION: Unreinforced masonry walls in buildings not having a rating classification of I may be analyzed in accordance with Section 91.6807.

TABLE NO. 68-C
HORIZONTAL FORCE FACTORS "IS"
FOR PARTS OR PORTIONS OF STRUCTURES

RATING CLASSIFICATION	IS
I	1.50
II	1.00
III & IV	0.75

(c) ANCHORAGE AND INTERCONNECTIONS: Anchorage and interconnection of all parts, portions and elements of the structure shall be analyzed and designed for lateral forces in accordance with Table No. 23-B and the equation $F_p = IC_pSW_p$ as modified by Table No. 68-C. Minimum anchorage of masonry walls to each floor or roof shall resist a minimum force of 200 pounds per lineal foot acting normal to the wall at the level of the floor or roof.

(d) LEVEL OF REQUIRED REPAIR: Alterations and repairs required to meet the provisions of this Division shall comply with all other applicable requirements of this Code unless specifically provided for in this Division.

(e) REQUIRED ANALYSIS:

1. GENERAL: Except as modified herein, the analysis and design relating to the structural alteration of existing structures within the scope of this Division shall be in accordance with the analysis specified in Division 23.

2. CONTINUOUS STRESS PATH: A complete, continuous stress path from every part or portion of the structure to the ground shall be provided for the required horizontal forces.

3. POSITIVE CONNECTIONS: All parts, portions or elements of the structure shall be interconnected by positive means.

(f) ANALYSIS PROCEDURE:

1. GENERAL: Stresses in materials and existing construction utilized to transfer seismic forces from the ground to parts or portions of the structure

shall conform to those permitted by the Code and those materials and types of construction specified in Section 91.6807.

2. CONNECTIONS: Materials and connectors used for interconnection of parts and portions of the structure shall conform to the Code.

3. UNREINFORCED MASONRY WALLS: Unreinforced masonry walls shall be analyzed to insure their capability of resisting superimposed vertical loads in addition to the seismic forces required by this Division. The 50 percent increase in the seismic force factor for shear walls as specified in Table No. 24-H may be omitted in the computation of seismic loads to existing shear walls.

Allowable stresses in such walls shall be obtained by tests utilizing values established by laboratory testing as specified in Section 91.6807 (e), however, no allowable tension stress will be permitted. Walls not capable of resisting the applied loads shall be strengthened to resist the forces specified in this Division or shall be removed and replaced:

EXCEPTIONS:

1. Unreinforced masonry walls in buildings not classified as a Classification Rating I may be analyzed in accordance with Section 91.6807.

2. Unreinforced masonry walls which carry no design loads other than its own weight may be considered as veneer if they are adequately anchored to new supporting elements.

(g) COMBINATION OF LOAD EFFECTS:

1. NEW MATERIALS: Combination of load effects shall conform to the Code for all new materials introduced into the building structure to meet the requirements of this section.

2. EXISTING MATERIALS: When stress in existing lateral force resisting elements are due to a combination of dead loads plus live loads plus seismic loads, the allowable working stress specified in the Code may be increased 100 percent. However, no increase will be permitted in the stresses allowed in Section 91.6807 of this Division and the stresses in members due only to seismic and dead loads shall not exceed the values permitted by Section 91.2301 (g).

3. ALLOWABLE REDUCTION OF BENDING STRESS BY VERTICAL LOAD: In calculating tensile fiber stress due to seismic forces required by this Division, the maximum tensile fiber stress may be reduced by the full direct stress due to vertical dead loads.

SECTION 91.6807 MATERIALS OF CONSTRUCTION:

(a) GENERAL: All materials permitted by this Code including their appropriate allowable stresses and those existing configurations of materials specified herein may be utilized to meet the requirements of this Division.

(b) EXISTING MATERIALS:

1. UNREINFORCED MASONRY WALLS: Unreinforced masonry walls analyzed in accordance with this section may provide vertical support for any roof and floor construction and resistance to lateral loads. The bonding of such walls shall be as specified in Section 91.2412 (b).

Tension stresses due to seismic forces normal to the wall may be neglected if the wall does not exceed the height or length to thickness ratio and the in-plane shear stresses due to seismic loads as set forth in Table No. 68-D

TABLE NO. 68-D
ALLOWABLE VALUE OF UNREINFORCED WALLS WITH MINIMUM QUALITY MORTAR[1]

UNSUPPORTED RATING CLASSIFICATION	MAXIMUM RATIO SEISMIC IN-PLANE HEIGHT OR LENGTH TO THICKNESS	SHEAR STRESS BASED ON GROSS AREA
I	Not Applicable[2]	Not Applicable[2]
II	9	3 psi[3]
III	10	3 psi[3]
IV	12	3 psi[3]

NOTES: [1]Minimum quality mortar shall be determined by laboratory testing in accordance with Section 91.6807 (e).

[2]Walls of buildings within rating classification I shall be analyzed in accordance with Section 91.6806 (f).

[3]Allowable shear stress may be increased in accordance with Section 91.6807 (g).

The wall height or length may be measured horizontally to supporting elements providing the stiffness of the supporting member is at least twice as stiff as the tributary wall. Stiffness shall be based on the gross section.

2. EXISTING ROOF, FLOORS, WALLS, FOOTINGS, AND WOOD FRAMING: Existing materials including wood shear walls utilized inthe described configuration may be used as part of the lateral load resisting system, provided that the stresses in these materials do not exceed the values shown in Table No. 68-E.

TABLE NO. 68-E
VALUES FOR EXISTING MATERIALS

MATERIALS[1]	ALLOWABLE VALUES
1. HORIZONTAL DIAPHRAGMS	
a. Roofs with straight sheating and roofing applied directly to the sheathing.	150 lbs. per foot for seismic shear.
b. Roofs with diagonal sheathing and roofing applied directly to the sheathing.	400 lbs. per foot for seismic shear.
c. Floors with straight tongue and groove sheathing.	150 lbs. per foot for seismic shear.
d. Floors with straight sheating sheathing and finished wood flooring.	300 lbs. per foot for seismic shear.
e. Floors with diagonal sheathing and finished wood flooring.	400 lbs. per foot for seismic shear.
f. Floors or roofs with straight sheathing and plaster applied to the joist or rafters.[2]	Add 50 lbs. per foot to materials la and lc.
2. SHEAR WALLS	
a. Wood stud walls with wood lath and plaster.	50 lbs. per foot each side for seismic shear.
b. Wood stud walls with plaster and lath other than wood lath.	100 lbs. per foot each side for seismic shear.
3. PLAIN CONCRETE FOOTINGS shown	f'_c = 1500 psi unless otherwise by tests.
4. DOUGLAS FIR WOOD No, 1 D.F.	Allowable stress same as
5. REINFORCING STEEL inch maximum.	f_t = 20,000 lbs. per square
6. STRUCTURAL STEEL inch maximum.	f_t = 20,000 lbs. per square

Notes: [1]Material must be sound and in good condition.

[2]The wood lath and plaster must be reattached to existing joists or rafters in a manner approved by the Department.

(c) STRENGTHENING OF EXISTING MATERIALS:

New materials including wood shear walls may be utilized to strengthen portions of the existing seismic resisting system in the described configurations provided that the stresses do not exceed the values shown in Table No. 68-F.

TABLE NO. 68-F
ALLOWABLE VALUES OF NEW MATERIALS USED IN CONJUNCTION WITH EXISTING CONSTRUCTION

NEW MATERIALS	ALLOWABLE VALUES
HORIZONTAL DIAPHRAGMS	
Plywood sheathing applied directly straight sheathing with ends of plywood sheets bearing on joists or rafters and edges of plywood located on center of individual sheathing boards.	Same as specified in Table over existing 25-J for over blocked diaphragms.
SHEAR WALLS	
a. Plywood sheathing applied directly over existing wood studs. No value shall be given to plywood applied over existing plaster or wood sheathing.	Same as values specified in Table 25-J for shear walls.
b. Dry wall or plaster applied directly over existing wood studs.	75 percent of the values specified in Table 25-N.
c. Dry wall or plaster applied to plywood sheathing over existing wood studs.	33-1/3 percent of the values specified in Table 25-N.
Shear bolts and shear dowels embedded a minimum of 8 inches into unreinforced masonry walls. Bolt centered in a 2-1/2-inch diameter hole with with dry pack or nonshrink grout around circumference of bolt or dowel.[1]	100 percent of the values for plain masonry specified in Table 24-F. No values larger than those given for 3/4-inch bolts shall be used.
Tension bolts and tension dowels extending entirely through unreinforced masonry walls secured with bearing plates on far side of wall with at least 30 square inches of area.[2]	1200 lbs. per bolt or dowel.
Reinforced masonry infilled openings in existing unreinforced masonry walls with dowels to match reinforcing.	Same as values specified for unreinforced masonry wall.
6. Masonry piers and walls reinforced per Section 91.2418 and designed for tributary loads.	Same as values specified in Table 24-G.
7. Concrete footings, walls and piers reinforced as specified and designed for tributary loads.	Same as values specified in Division 26.
8. Foundation pressures for structures exhibiting no evidence of settlement.	Calculated existing foundation pressures due to maximum load plus live load may be increased 25% for dead load, and may be increased 50% 50% for dead load plus seismic load required by this Division.

NOTES: [1]Bolts and dowels to be tested as specified in Section 91.6807 (f).

[2]Bolts and dowels to be 1/2-inch minimum in diameters.

(d) ALTERNATE MATERIALS: Alternate materials and methods of construction may be approved by the Department in accordance with the provisions of Article 8, Chapter 9 of the Los Angeles Municipal Code.

(e) MINIMUM ACCEPTABLE QUALITY OF EXISTING UNREINFORCED MASONRY WALLS:

1. GENERAL PROVISIONS: All unreinforced masonry walls utilized to carry vertical loads and seismic forces parallel and perpendicular to the wall plane shall be tested as specified in this section. All masonry quality shall equal or exceed the minimum standards established herein or shall be removed and replaced by new materials. Alternate methods of testing may be approved by the Department. Nothing shall prevent pointing with cement mortar of all masonry wall joints before the tests are first made. If the exterior joints are pointed, then the inside face must also be pointed. Prior to any pointing, the wall surface must be sand or water blasted to remove loose and deteriorated mortar. All preparation and

cement mortar pointing shall be done under the continuous inspection of a registered deputy inspector with a subsequent written report to the Department. All testing shall be performed by an approved testing agency in accordance with the requirements specified in this Subsection.

EXCEPTION: Unreinforced masonry walls which carry no design loads other than its own weight may be considered as veneer if they are adequately anchored to new supporting elements.

2. NUMBER AND LOCATION OF TESTS: The quality of mortar in all masonry walls shall be determined by performing in place shear tests or by testing eight-inch diameter cores. The minimum number of tests shall be two per wall or line of wall elements resisting a common force, or one per 1500 square foot of wall surface, with a minimum of eight tests in any case. The exact test or core location shall be determined at the building site by the licensed engineer or architect responsible for the seismic analysis of the subject building. The results of all tests or coring shall be recorded and reported.

3. IN-PLACE SHEAR TESTS: The bed joints of the outer wythe of the masonry shall be tested in shear by laterally displacing a single brick relative to the adjacent bricks in that wythe. The opposite head joint of the brick to be tested shall be removed and cleaned prior to testing. The minimum quality mortar in 80 percent of the shear tests shall not be less than the total of 30 psi plus the axial stress in the wall at the point of the test. The shear stress shall be based on the gross area of both bed joints and shall be that at which movement of the brick is first observed.

4. CORE TESTS: A minimum number of mortar test specimens equal to the number of required cores shall be prepared from the cores and tested as specified herein. The mortar joint of the outer wythe of the masonry core shall be tested in shear by placing the circular core section in a compression testing machine with the mortar bed joint rotated 15 degrees from the axis of the applied load. The mortar joint tested in shear shall have an average ultimate stress based on the gross area of 20 psi. The average shall be made from the total number of cores made. If test specimens cannot be made from cores taken, the shear value shall be reported as zero. The results of all coring and shear testing shall be reported.

(f) TESTING OF SHEAR BOLTS: One-fourth of all new shear bolts and dowels embedded in unreinforced masonry walls shall be tested by a registered deputy inspector using a torque calibrated wrench to the following minimum torques:

1/2" diameter bolts or dowels = 40 foot-lbs.

5/8" diameter bolts or dowels = 50 foot-lbs.

3/4" diameter bolts or dowels = 60 foot-lbs.

No bolts exceeding 3/4 inch shall be used. All nuts shall be installed over malleable iron or plate washers when bearing on wood and heavy cut washers when bearing on steel.

(g) DETERMINTION OF ALLOWABLE STRESSES FOR DESIGN METHODS BASED ON TEST RESULTS:

1. DESIGN SHEAR VALUES: Design seismic in-plane shear stresses greater than permitted in Table No. 68-D shall be substantiated by tests performed as specified in Section 91.6807 (e) 3 and 4.

Design stresses shall be related to test results obtained as noted in Table No. 68-G. Intermediate values between 3 and 5 psi may be interpolated.

TABLE NO. 68-G
ALLOWABLE SHEAR STRESS FOR TESTED UNREINFORCED MASONRY WALLS

EIGHTY PERCENT OF TEST RESULTS IN PSI NOT LESS THAN	AVERAGE TEST RESULTS OF CORES IN PSI	SEISMIC IN-PLANE SHEAR BASED ON GROSS AREA
30 plus axial stress	20	30 psi[1]
40 plus axial stress	27	4 psi[1]
50 plus axial stress or more	33 or more	5 psi[1]

NOTES: [1]Allowable shear stress may be increased by addition of 10% of the axial stress due to the weight of the wall directly above.

[2]DESIGN COMPRESSION and TENSION VALUES. Compression stresses for unreinforced masonry having a minimum design shear value of 3 psi shall not exceed 100 psi. Design tension values for unreinforced masonry shall not be permitted.

SECTION 91.6808. INFORMATION REQUIRED ON PLANS:

(a) GENERAL: In addition to the seismic analysis required elsewhere in this Division, the license engineer or architect responsible for the seismic analysis of the subject building shall determine and record the information required by this Section on the approved plans.

(b) CONSTRUCTION DETAILS: The following construction details shall be made part of the approved plans:

1. All unreinforced masonry walls shall be anchored to all floors and roofs with tension bolts through the wall or by existing rod anchors at a maximum anchor spacing of six feet. All existing rod anchors shall be secured to joists or rafters by bolting to develop the required forces. The Department may require testing to verify adequacy of embedded ends of existing rod anchors.

2. Diaphragm chord stresses of horizontal diaphragms shall be developed in existing materials or by addition of new materials.

3. Where wood roof or floor members other than rafters or joists are supported in masonry pockets, ledgers or columns shall be installed to support vertical loads of the roof or floor members.

4. Parapets and exterior wall appendages not capable of resisting the forces specified in this Division shall be removed, stabilized or braced to insure that the parapets and appendages remain in their original position.

5. All deteriorated mortar joints in unreinforced masonry walls shall be pointed with cement mortar. Prior to any pointing, the wall surface must be sand or water blasted to remove loose and deteriorated mortar. All preparation and pointing shall be done under the continuous inspection of a registered deputy masonry or concrete inspector with a subsequent written report to the Department.

6. Repair details of any cracked or damaged unreinforced masonry wall required to resist forces specified in this Division.

(c) EXISTING CONSTRUCTION: The following existing construction information shall be made part of the approved plans:

1. The approximate age of building.

2. The typical footing width, depth and maximum soil bearing for dead plus live loads.

3. The type and dimensions of existing walls and the size and spacing of floor and roof members.

4. The extent and type of existing wall anchorage to floors and roof.

5. The extent and type of parapet corrections which were performed in accordance with Section 91.0103 (b).

6. Accurately dimensioned floor plans and masonry wall elevations showing dimensioned openings, piers, wall thickness and heights.

7. The location of cracks or damaged portions of unreinforced masonry walls requiring repairs.

8. The type of interior wall surfaces and if reinstalling or anchoring of ceiling plaster is necessary.

9. The general condition of the mortar joints and if the joints need pointing.

APPENDIX 4

Appendix Chapter 12 of the 1979 Uniform Building Code, "Existing Buildings"

UNIFORM BUILDING CODE

Chapter 12

EXISTING BUILDINGS

Existing Buildings

Sec. 1215. (a) Purpose. The purpose of this section is to provide a reasonable degree of safety to persons living and sleeping in apartment houses and hotels through providing for alterations to such existing buildings as do not conform with the minimum safety requirements of this code.

(b) Scope. The provisions of this section shall apply exclusively to existing nonconforming Group R, Division 1 Occupancies more than two stories in height.

(c) Effective Date. Eighteen months after the effective date of this section, every building falling within its scope shall be vacated until made to conform to the requirements of this section.

(d) Number of Exits. Every apartment and every other sleeping room shall have access to not less than two exits. A fire escape as specified herein may be used as one required exit.

Subject to the approval of the building official, a ladder device as specified herein may be used in lieu of a fire escape when the construction features or the location of the building on the property cause the installation of a fire escape to be impractical.

(e) Stair Construction. All stairs shall have a minimum run of 9 inches and a maximum rise of 8 inches and a minimum width exclusive of handrails of 30 inches. Every stairway shall have at least one handrail. A landing having a minimum horizontal dimension of 30 inches shall be provided at each point of access to the stairway.

(f) Interior Stairways. Every interior stairway shall be enclosed with walls of not less than one-hour fire-resistive construction.

Where existing partitions form part of a stairwell enclosure, wood lath and plaster in good condition will be acceptable in lieu of one-hour fire-resistive construction. Doors to such enclosures shall be protected by a self-closing door equivalent to a solid wood door not less than 1 3/4 inches thick. Enclosures shall include landings between flights and any corridors, passageways or public rooms necessary for continuous exit to the exterior of the building.

The stairway need not be enclosed in a continuous shaft if cut off at each story by the fire-resistive construction required by this subsection for stairwell enclosures.

Enclosures shall not be required if an automatic sprinkler system is provided for all portions of the building except bedrooms, apartments and rooms accessory thereto.

(g) Exterior Stairways. Exterior stairs shall be noncombustible or of wood of not less than 2-inch nominal thickness with solid treads and risers.

(h) Fire Escapes, Exit Ladder Devices. 1. Fire escapes may be used as one means of egress, if the pitch does not exceed 60 degrees, the width is not less than 18 inches, the treads are not less than 4 inches wide, and they extend to the ground or are provided with counterbalanced stairs reaching to the ground. Access shall be by an opening having a minimum dimension of 29 inches when open. The sill shall be not more than 30 inches above the floor and landing.

2. A ladder device when used in lieu of a fire escape shall conform to U.B.C. Standard No. 33-3 and the following:

A. Serves an occupant load of nine people or less or a single dwelling unit or hotel room.

B. The building does not exceed three stories in height.

C. The access is adjacent to an opening as specified for emergency egress of rescue or from a balcony.

D. The device does not pass in front of any building opening below the unit being served.

E. The availability of activating the latdder device is accessible only to the opening or balcony served.

F. The device as installed will not cause a person using it to be within 12 feet of exposed energized high-voltage conductors.

(i) Doors and Openings. Exit doors shall meet the requirements of Sections 3303 (b), (c) (d) and 3304 (h). Doors shall not reduce the required width of stairway more than 6 inches when open. Transoms and openings other than doors from corridors to rooms shall be fixed closed and shall be covered with a minimum of 3/4-inch plywood or 1/2-inch gypsum wallboard of equivalent material.

EXCEPTIONS: 1. Existing solid bonded wood core doors 1 3/8 inches thick of their equivalent may be continued in use.

2. Where the existing frame will not accommodate a door complying with Section 3304 (h), a 1 3/8-inch-thick solid-bonded wood core door may be used.

(j) Exit Signs. Every exit doorway or change of direction of a corridor shall be marked with a well-lighted exit sign having letter at least 5 inches high.

(k) Enclosure of Vertical Openings. Elevators, shafts, ducts and other vertical openings shall be enclosed as required for stairways in Subsection (f) or by wired glass set in metal frames. Doors shall be noncombustible or as regulated in Subsection (f).

(l) Separaton of Occupancies. Occupancy separations shall be provided as specified in Section 503. Lobbies and public dining rooms, not including cocktail lounges, shall not require a separation if the kitchen is so separated from the dining room.

Every room containing a boiler or central heating plant shall be separated from the rest of the building by not less than a one-hour fire-resistive occupancy separation.

EXCEPTION: A separation shall not be required for such rooms with equipment serving only one dwelling unit.

(m) Alternates. No alternate method of obtaining the fire protection and safety required by this section may be used unless the Board of Appeals, including as a voting member for this purpose the chief of the fire department, finds that such alternate method provides protection and safety equivalent to that required herein.

APPENDIX 5

Denver, Colorado

DENVER, COLORADO

General Code Requirements

Denver, Colorado operates under a local code based primarily on the 1973 Uniform Building Code which includes the 25-50% Rule, and the general change of use regulation. In December 1976, Denver enacted Chapter 31, "Rehabilitation of Older Buildings," into its code. Cahpter 31 excludes from the 25-50% Rule and from the change of use regulation all buildings erected before 1950 of the following occupancies:

- o assembly less than 300;
- o educational and day-care centers;
- o business (including retail stores);
- o hotels;
- o apartments;
- o lodging houses; and
- o residences.

Reportedly, passage of Chapter 31 came about because of recognition on the part of community and building officials that it would not be economically feasible to rehabilitate older buildings under the 25-50% Rule, or when changing occupancy or increasing intensity of use. Hence, Section 3101 (b) states:

> "It is hereby declared as a matter of public policy, that the rehabilitation, preservation, and restoration of older buildings located within the city is a public necessity, and is required in the general interests of the people."

The chapter further establishes a "Rehabilitation Advisory Panel" of twenty-five (25) persons from the building community. This panel was established to develop guidelines for use by the building official in approving requested deviations from the code for new construction for rehabilitation work. The guidelines identify the clauses of the code for which the building official shall consider deviations, but does not define specific requirements. (See below.)

Provision is made for subpanels consisting of four (4) to eight (8) members of the Rehabilitation Advisory Panel to advise the

building official on single applications. The subpanel recommendations are advisory. The building official makes the final decision.

The City of Denver has actually created two paths to code compliance with Chapter 31. It is up to the applicant to determine if the Chapter 31 route is used; otherwise, the 25-50% Rule and change of use regulation apply. The applicant chooses the Chapter 31 route by submitting a special application form noting the deviations from new code requirements requested.

Operation of the Code

In 1978 Chapter 31 was used about thirty times and is being used at about twice that rate in 1979. The system is reportedly working well. It is being used primarily for buildings which are quite old--late 1800's and early 1900's--and often with a change in use. Apparently, the building official does not always follow the subpanel recommendations.

Chapter 31 creates a dichotomy; that is, the building types covered in Chapter 31 do not have to meet the 25-50% Rule when being rehabilitated, while all other types do. Thus, there is a lack of uniformity in code treatment of the two classes of building. Nevertheless, the concept that public safety, at least in the selected building types, can be secured to a reasonable degree through the use of the "Preliminary Guidelines" is worthy of further consideration. It is clear from a reading of the Preliminary Guidelines that they represent an attempt to set a standard for existing buildings that is less stringent and more flexible than that for new buildings in the categories covered. This concept is illustrated in the following example.

Part (d) of the "Preliminary Guidelines" allows consideration and approval of stairs not meeting the width, rise and run dimensional limits specified for new construction. Code requirements for new buildings demand a minimum 36" exit stair in all circumstances. Using Part (d) 1, it is now possible to approve a stair somewhat narrower, but of sufficient width to still adequately provide for the safe exit of building occupants. Underpinning this approach is the concept that specific non-complying dimensions and attributes of an existing building can be accepted, if as a whole the building provides adequate public safety, while not meeting each new building requirement. It is unclear from this example, however, whether the Denver approach is one of equivalency or one of reduced performance.

The Denver approach is essentially a policy statement showing commitment to rehabilitation, followed by an administrative technique for approving deviations from the code for new construction on a case-by-case basis. It does provide for advice to the building official, but it is the building official who makes the final decision. To that extent, the system operates similarly to those rehabilitation projects falling in the 25% to 50% range. The guidelines do indicate to the user and building official those areas in which deviations will be considered.

If the deviations granted under Chapter 31 were recorded and catalogued, they might form the basis for a rehabilitation "code" but there is no indication that this is being done.

CHAPTER 31

REHABILITATION OF OLDER BUILDINGS

SECTION 3101. GENERAL.

(a) Scope. This Chapter shall govern the rehabilitation of buildings, structures, and utilities in Group B-3, C,F,H,I and J occupancies which were built prior to January 1, 1950, and shall supersede all the requirements of this Building Code which are in conflict with the provisions of this Chapter.

EXCEPTION: This Chapter shall not supersede the requirements of Chapter 1 relating to unsafe buildings, structures, or utilities.

(b) Declaration. It is hereby declared, as a matter of public policy, that the rehabilitation, preservation, and restoration of older buildings located within the City is a public necessity and is required in the interest of the general welfare of the people. Special consideration shall be given to buildings that are Denver Landmarks or buildings on the National Register of Historic Places and National Historic Districts.

EXCEPTION: Existing buildings, structures, or utilities may be granted an exception allowing the repair, rehabilitation, or change of occupancy of a building where the planned repairs, rehabilitation, or change of occupancy would not comply with the provisions of this Building Code. No exception shall be authorized hereunder unless the Director shall find the following conditions exist:

1. The building was constructed prior to January 1, 1950.
2. The building, structure, or utility is structurally sound and the proposed repair, rehabilitation, or change of occupancy will substantially improve the use, safety, and welfare of the occupants.
   A. The Director, in making this determination, may request an Engineer's or Architect's report to determine the condition of the building, structure, or utility.
3. The proposed repair or rehabilitation of a building, structure, or utility for residential use does not violate the provisions of the Housing Code, Article 631, Revised Municipal Code.
4. The Fire Department concurs in an alternative method, utility, appliance, or system related to fire safety.

SECTION 3102. REHABILITATION ADVISORY PANEL.

(a) Creation. An Advisory Panel of 25 persons, with experience in the rehabilitation of buildings, structures, or utilities shall be appointed by the Mayor. Individual members of City Council may submit names to the Mayor for consideration for appointment to the Advisory Panel. Their term of office shall be as follows:
1. Five persons shall be appointed for a term of 1 year.
2. Five persons shall be appointed for a term of 2 years.
3. Five persons shall be appointed for a term of 3 years.
4. Five persons shall be appointed for a term of 4 years.
5. Five persons shall be appointed for a term of 5 years.

After the initial appointments are made, each appointment shall be made for a 5 year term. The Advisory Panel shall serve without compensation.

(b) Composition of Advisory Panel. The Advisory Panel shall consist of the following:
1. Three members shall be Architects.
2. Three members shall be Engineers.
3. Two members shall be holders of a Class A or B Construction License.
4. Two members shall be holders of a Plumbing Contractor's Class A License; and one member shall be the holder of a Plumbing Journeyman's Certificate.
5. Two members shall be holders of a Heating and Ventilating Contractor's Class A License; and one member shall be the holder of a Heating and Ventilating Journeyman's Certificate.
6. Two members shall be holders of a Steam and Hot Water Contractor's Class A License; and one member shall be the holder of a Steam and Hot Water Journeyman's Certificate.
7. Two members shall be holders of an Electrical Contractor's Class A License; and one member shall be the holder of an Electrical Journeyman's Certificate.
8. The remaining five members of the Advisory Panel shall be appointed from the real estate and financial field.

(c) Vacancy. Should a vacancy occur on the Advisory Panel during a member's term, the Mayor may fill the vacancy for the unexpired term. Any member of the Advisory Panel, after serving a complete term, may be reappointed to another full term.

(d) Guidelines: The Advisory Panel shall adopt guidelines for use by the Director in determining compliance with this Chapter.

(e) The Advisory Panel may adopt rules, procedures, and organization.

SECTION 3103. COMPLIANCE. The Director, in determining compliance with the conditions set forth in this Chapter, may or shall, upon request of the applicant, establish a Sub-Panel consisting of 4 to 8 members of the Advisory Panel; a member of the Department of Health and Hospitals; and the Fire Department.

SECTION 3104. CONSIDERATION. The requirements of this Building Code shall be met in the rehabilitation of all buildings, structures, and utilities; but consideration for an exception may be given to existing buildings, structures, and utilities deemed safe and useable by the Department.

PRELIMINARY GUIDELINES FOR USE BY THE DIRECTOR

The preliminary guidelines are established in order to direct committees attention to areas of special concern. The panel directs committees appointed hereunder to consider all areas and to report any required revisions in these guidelines. It is the intent of the panel to review the preliminary guidelines and revise them within 60 days.

Guidelines for use by the Director and the Advisory Panel in determining compliance with Chapter 31 of the Denver Building Code are herein itemized. In considering the following items it must be kept in mind that the building, structure or utility must be structurally sound and the proposed repair, rehabilitation, or change of occupancy must substantially improve the use, safety and welfare of the occupants.

(a) Fire Protection Systems. (Chapter 38)

1. Standpipes, Pumps and Connections.

A. The use of existing fire protection appliances, when approved by the Department and Fire Department to determine that they are serviceable.

B. The distance to standpipes not meeting the precise locations of Chapter 38.

2. Fire Detection and Fire Alarm Systems.

A. Partial fire detection systems and manual fire alarm and central stations.

B. Smoke detection systems in lieu of other requirements.

3. Openings.

A. Window openings (size, number and location)

B. Vertical openings (stairways, escalator opening, elevator shafts).

4. Pressures. Requirements for pressure standards.

(b) Heating, Cooling and Venting Systems. (Chapter 37, 31, 32, and 38).

1. Access to cleanouts in crawl spaces. Chapter 37.

2. Depth of cleanout wells in chimneys of less than 12 inches. Chapter 37.

3. Clearances for chimneys and vents. Chapter 57.

4. Utilization of existing duct systems which do not provide conforming weights and gauge. Chapter 52.

5. Existing systems that do not meet the clearance requirements. Chapter 52.

6. Outside air intakes. Chapter 52.

7. Steam, hot water and process piping do not meet the requirements of Chapter 58 and when no safety hazard is apparent.

(c) Electrical. (Chapter 53)

1. Required wiring method when it serves only outlets and equipment for which it was originally designed.

2. Grounding and bonding when it meets the minimum standards for personnel protection, fire safety and is compatible with occupancy and the environment it serves.

3. Knob and tube wiring and ungrounded non-metallic cable wiring.

4. Panels in boiler rooms or heating rooms.

(d) Stairs, Exits and Occupant Loads. (Chapter 33)

1. Stairs and exits not meeting the specific minimum requirements of Chapter 33 (width, rise and run).
2. Stairs and exits not meeting the specific number and precise location requirements of Chapter 33 (distance between, occupancy loan, etc).
3. Reduced floor loading. Chapter 23
4. Secondary exits not in complete compliance with Chapter 33.
7. Rise more than, and run less than that required in Chapter 33.
8. Distances between landings (vertical) more than required in Chapter 33.
9. Ramps with width less than those required in Chapter 33.

   EXCEPTION: Contemplation of wheel chair use.

10. Open stairs.

(e) Plumbing. (Chapter 50)

1. Use of existing operating leadwork, trap and venting systems or replacement and duplication of old system with new materials.
2. Variance in use of, support of, cleanout requirements, sizing, venting and methods of connection of serviceable drain piping regardless of material or installation method. Alternate methods of testing where impractical to pressure test.
3. Variance in types, sizes and materials of water piping, method of connection, location, frost line depth and requirements for individual control valves.
4. Variance in practices, materials, or installation of plumbing where alteration would require unnecessary, difficult, or impractical changes in plumbing, piping or connection to conform to plumbing code.

APPENDIX 6

Washington, D.C.

WASHINGTON, D. C.

General Code Provisions

The District of Columbia uses a locally developed code loosely based on the Basic Building Code format. The code incorporates neither the 25-50% Rule nor the general change in use regulation. It does, however, contain provisions (basically prescriptive) specifically addressing existing buildings and also specific provisions applied when a change in use occurs.

In general, the code provides for several levels of code compliance as follows:

i Code in effect when building was erected.

ii Retroactive provisions:

- o most exclude one and two family,
- o some exclude certain buildings under three stories.

iii Provisions concerning alteration or conversion.

iv Provisions for new construction.

The code also incorporates a hazard ranking by occupancy type and intensity of use. Conversion is defined as a change to a higher hazard use. Alteration is defined as work which affects egress arrangements or fire resistivity.

In general, the provisions concerning alteration or conversion are less stringent than for new buildings in both fire ratings and egress. The retroactive provisions are still less stringent than either category. Both of these classes of provisions cover primarily egress and fire resistivity.

The code provisions were developed over a long period of time and were based essentially on allowing certain deviations from the requirements for new construction for existing, altered or converted buildings.

Following this discussion are the primary sections of the District of Columbia code covering alteration and conversion of existing buildings. These sections include:

- o Section 100.12 - Buildings Altered or Converted (general application)
- o Section 100.13 - Existing Buildings (general application)

- Section 504 - Buildings Altered or Converted (light, ventilation and space requirements)
- Section 312 - Buildings Altered or Converted (covers height and area, change in occupancy, projections, fire-resistance requirements)
- Sections 663-639- Buildings Altered or Converted (egress requirements)
- Sections 640-650- Existing Buildings (egress requirements)
- Section 629 - Buildings Altered or Converted (fire and flame resistance requirements)
- Section 1008 - Existing Installations (chimneys, vents and fireplaces)

Operation of the Code

In the absence of a 25-50% Rule, any building may be repaired and rehabilitated complying only with the code in effect when it was erected, plus those retroactive provisions for existing buildings which apply to it. Compliance with the more stringent provisions for altered or converted buildings becomes necessary only when the use of the building is changed to one of greater hazard.

For example, the District of Columbia contains many three-story and basement row dwellings. When a one- or two-family row dwelling is rehabilitated, it need be in compliance only with the code in effect when it was built, e.g., replace with like materials and systems. Note that one- and two-family dwellings are generally excluded from retroactive provisions. If, on the other hand, it is converted to three or four apartments, it must meet the more stringent requirements for conversion, such as enclosure of exits, fire alarms, detectors, etc.

Because of format and references, it is necessary to be familiar with the total code in order to result in the most economical method to meet retroactive provisions or to alter or convert a building. In each instance, several options are generally available. Following is a much simplified example of optional egress requirements for an existing, non-fire resistive construction (Type 3) building with eight dwelling units and two open stairways:

i Retroactive Provisions:

- Option 1 - Enclose both stairways.
- Option 2 - Fully enclose one stairway, partially enclose the other.
- Option 3 - Partially enclose one stairway and provide fire escapes for each apartment.

ii Alteration or Conversion Provisions:

- Option 1 - Enclose both stairways (may still have to provide fire escapes, depending upon building layout).
- Option 2 - Enclose one stairway, partially enclose second and provide fire escapes.

iii New Construction:

- No option - Must have two Class A enclosed stairways.

This concept of specific written provisions for multi-level code enforcement, e.g., existing, retroactive, altered or converted, and new construction, accomplishes several goals:

- It provides for less stringent requirements than for new construction.
- It minimizes discretionary authority, and hence, minimizes the legal liability or the preception of such liability, of the inspector or building official.
- It eliminates value or cost of rehabilitation as a factor--the provisions are based on the need to secure reasonable minimum levels of life safety.

APPENDIX 2

Primary Sections of Washington, D. C. Code
Concerning Existing Buildings, Alterations,
and Conversions

Sec. 100.12 Buildings Altered or Converted.

100.121 Buildings Erected After February 1, 1951. Buildings for which a permit application was filed on or after February 1, 1951, for the purpose of altering or converting, shall comply with all applicable requirements of this Code with respect to such alterations or conversions.

100.122 Buildings Erected Before February 1, 1951. Buildings for which a permit application was filed before February 1, 1951, for the purpose of altering or converting, shall comply with the requirements of Sections 634.0 through 640.0 of Article 6.

Sec. 100.13 Existing Buildings.

Buildings and structures for which application for permit to construct was filed prior to the effective date of this Code, shall be subject to 100.12 on Maintenance, and Sections 641.0 through 650.0 of Article 6.

SECTION 312.0 - BUILDINGS ALTERED OR CONVERTED

Sections
312.1 Increase in Height
312.2 Increase in Area
312.3 Change in Occupancy
312.4 Existing Projections
312.5 Fire-Resistance Requirements

Sec. 312.1 Increase in Height

(1) No building shall be increased in height unless, with the increased height, it meets the fire-resistance requirements of this Code.

(2) Minor variations from such required fire-resistance for the existing part of the building may be allowed by the Director.

Sec. 312.2 Increase in Area.

(1) When a building is increased in area, the new part shall conform with the requirements of this Code for new construction.

(2) In case the required fire-resistance ratings of constructions in the addition differ from those for the existing building by 3/4 hour or more, or the addition is of a different type of construction of a lower fire rating, a fire separation per § 303.5 shall be provided.

Sec. 312.3 Change in Occupancy.

(1) No change in occupancy to one requiring greater fire-resistance for the building or lesser height or area, shall be made unless the building conforms, or is altered to conform with the requirements of this Code for the new occupancy.

(2) Changes in use which present similar fire or occupancy hazards, may be made.

Sec. 312.4 Existing Projections.

No structural alterations shall be made to existing projections which change their projection on public space, unless such projections be made to conform with the requirements of Section 311.0 of this Article.

Sec. 312.5 Fire-Resistance Requirements.

(1) Requirements for Types 1, 2 and 3 Construction. The requirements shall be the same as for new construction except as provided herein.

1. Existing Buildings. When buildings, erected prior to July 1, 1925, are altered or converted, in lieu of the required Type 1 main floor, such main floor shall be protected on the underside with incombustible material having not less than a one-hour fire-resistance rating, including columns and beams. All floors below the main floor of such buildings shall be subdivided into fire areas not exceeding 1,500 square feet. The above fire protection and subdivision of floors below the main floor is in lieu of a Type 1 main floor. Existing non-fire-resistive exit and public corridors and stair landings shall be covered on top with a minimum of 3/8 inch thickness of incombustible material, or other material of such thickness

and type as may be approved by the Director. The soffits of such stairs, both sides of stud partitions, and exit and public corridor ceilings, shall be protected with incombustible material having a fire resistance rating of not less than one hour. The spaces between floor joists running at an angle with the corridor partitions, directly above and below, shall be fire stopped with incombustible materials. The space between stair stringers shall be fire stopped at the top and bottom of the stairs. All stairs extending below the main floor shall terminate in a 2-hour incombustible enclosure with a Class B self-closing door entering thereto. Doors leading from such corridors shall be Class C self-closing. Transoms shall be removed and the openings protected.

(2) Requirements for Type 4 Construction. In general, existing Type 4 Buildings shall not be altered or converted to any use other than L-2, except that existing Type 4 Buildings, not over 3 stories or forty feet in height, may be altered or converted to Group E, C or F-4B occupancies under the following conditions:

a. The existing frame exterior walls shall be provided with a nominal 4 inch thick masonry veneer or an exterior surface of incombustible material providing an overall 3/4 hour fire-resistance rating.

b. Existing masonry party walls may remain unchanged. Existing frame party walls shall be provided with a minimum 3/4 hour fire-resistance rating, or the wood lath and plaster removed on one side, stud spaces filled solidly with mineral wool and minimum of 3/4 inch gypsum plaster on metal lath or 1/2 inch gypsum plaster on gypsum lath 1/2 inch of approved fire resistant rated gypsum sheet rock applied to that side.

c. The fire areas within the basements shall be limited to 1500 square feet between fire walls and in all stories above the basement fire areas shall be limited to 2500 square feet between fire walls.

d. The total capacity of the Building shall not exceed 150 persons with the second floor limited to 75 persons. The Group E, C or F-4B occupancy shall be limited to the basement, first and second floors.

e. All other applicable provisions of this Code, including fire resistivity (other than exterior walls), egress, light and ventilation for altered and converted buildings, shall be in full force and affect.

1. Outside of Fire Limits. Open porches, not projecting into public space, may be enclosed but such enclosure shall constitute an addition and shall comply with all zoning and building code requirements for additions. (For construction of porches on public spaces see § 311.11.)

2. Inside of Fire Limits.

a. Wood frame buildings may be moved within their original lot lines, or may be moved to any area in which such construction is permitted, but shall not be moved to any other site within fire limits, except by approval of the Commissioner.

b. A Type 4 building, deteriorated or damaged beyond one-half of its present reconstruction value, may not be repaired, altered, or rebuilt. The amount or extent of such deterioration or damage, shall be determined by the Commissioner.

c. Enlargement. A Type 4 building depreciated to the extent noted under subsection 2. above, may be enlarged by wood frame construction as follows, provided the requirements for light and ventilation of all rooms affected are complied with, and such construction complies with all applicable requirements of this Code: 1. A one or two-story extension may be added to the rear of an original structure subject to the requirement that the sum of all extensions to the rear of such original structure shall not cover more than 120 square feet of ground area. 2. A second story not exceeding 120 square feet of floor area may be erected on an existing one-story extension, on the rear of an original structure, but in such case no further extension shall be permitted.

d. Increase in Wall Height. Exterior wood frame walls shall not be increased in height except as follows: 1. Where the top story or an attic was constructed and used for human habitation, and the ceiling height is less than required, such walls may be increased sufficiently to provide the ceiling height required by this Code. 2. A flat roof covered with metal or other incombustible material may be substituted for a gable or pitched roof, provided the cubic contents of the top story is not increased.

SECTION 504.00 - BUILDINGS ALTERED OR CONVERTED

Sections
504.1 Skylights
504.2 Ceiling Heights
504.3 Sunporches

Sec. 504.1 Skylights.

In the alteration or conversion of existing habitable rooms having insufficient window area, additional light and ventilation may be provided by means of skylights up to 50 percent of the total area required.

Sec. 504.2 Ceiling Heights.

504.21 Habitable Rooms. In the alteration or conversion of buildings existing prior to July 10, 1942, habitable rooms shall have a clear height of not less than seven feet in at least the minimum floor area required under Section 501.2.

504.22 Occupiable Rooms. In the alteration or conversion of buildings erected prior to January 8, 1952, occupiable rooms shall have a clear ceiling height of not less than seven feet.

504.23 Minimum Headroom. The minimum headroom shall conform with the requirements of Section 501.5.

Sec. 504.3 Sunporches.

In the construction of sunporches on existing single-family dwellings a variation of ten percent will be permitted of the required glazed areas under Section 502.5, when full compliance with the requirements would involve exceptional structural difficulties.

SECTION 633.0 - BUILDINGS ALTERED OR CONVERTED

Sections
633.1 Scope
633.2 Applicability
633.3 Grouping of Occupancies
633.4 Conditions for Conversion
633.5 Additions
633.6 Allowable Variance
633.7 Doors Projecting Beyond Building Line

Sec. 633.2 Scope.

The requirements of this Section apply only to the scope of the work contained in the permit.

Sec. 633.2 Applicability.

(1) The provisions under Sections 633.0 through 639.0 of this Article shall apply to buildings which were existing or under construction, or for which an application for a permit to construct, alter or convert was made prior to March 8, 1946.

(2) Where there are no specific provisions in Sections 633.0 through 639.0 applying to the alteration or conversion of any such building, or part thereof (see §§ 633.5 and 633.6), then such building or part thereof shall be made to comply with the pertinent provisions of Sections 601.0 through 632.8 which also apply to alterations, or conversion, in buildings erected after Feb. 1, 1951.

(3) In the enforcement of Sections 633.1 and 633.2(1) and (2), the application thereof to the areas affected shall include all areas in which work is to take place, and if said work imposes a greater burden upon the structure or means of egress, then, in such event, the Director shall include, as a part of the scope of work covered by the application, other areas directly affected as a result of the work performed.

(4) Nothing in this Article shall be construed to waive the requirements of the Act of Congress of June 1, 1910 as amended. (36 Stat. 452.)

Sec. 633.3 Grouping of Occupancies.

In general, the following classification by groups of occupancies, beginning with the most hazardous, shall be used to determine the order in which occupancies shall be considered hazardous to life, but shall not be construed to waive requirements of this Code which may be imposed due to the use, height, size, or capacity for occupancy of any building.

(1) High Hazard Group A buildings.
(2) Institutional Group H-1 buildings.
(3) Institutional Group H-2 buildings.
(4) Theatres, Group F-1 Assembly buildings.
(5) Assembly Group F-2 buildings with capacity of 300 or more.
(6) Assembly Group F-3 buildings with capacity of 300 or more.
(7) Assembly Group F-4A buildings with capacity of 300 or more.
(8) Assembly Group F-4B buildings with capacity of 300 or more.

(9) Residential Group L-1 buildings.
(10) Assembly Groups F-2, F-3, or F-4A buildings with capacity under 300.
(11) Assembly Group F-4B buildings with capacity under 300.
(12) Mercantile Group C buildings.
(13) Industrial Group D buildings.
(14) Storage Group B buildings, including public parking and storage garages.
(15) Business Group E buildings.
(16) Residential Group L-2 buildings.
(17) Miscellaneous uses, the relative hazard of which to be determined by the Director.

Sec. 633.4 Conditions for Conversion.

(1) Any building may be converted, from one type of occupancy to another within any group of occupancies of the same or lesser hazard, without incurring additional requirements within the limits of this Section, provided that fire-resistivity or egress facilities are not reduced, that no increase is made in height or size, that the capacity for occupancy is not so increased as to require additional egress facilities.

(2) Buildings may be converted to occupancies of greater hazard, but the requirements for fire-resistivity, egress facilities and other applicable requirements for the new occupancy must be fulfilled. See Tables 5 and 6 of Article 2 and Section 312.0 of Article 3.

(3) Existing Type 3B Buildings, not over four stories in height, may have those stories below the top two stories converted to Group C and/or Group F-2 Occupancies; provided, that a minimum of 1-1/2 hours fire separation is provided between the various occupancies.

Sec. 633.5 Additions.

(1) Additions in Area. Additions increasing the floor area of existing buildings shall be considered as new construction and shall comply with all applicable provisions of Sections 601.0 through 632.8 of this Article.

(2) Addition of Stories. No alterations or additions shall be made which increase the number of stories of an existing building unless the stairs and exit corridors directly affected by the addition are made to comply with all applicable provisions of Sections 601.0 through 632.8 of this Article. In connection herewith, the removal of earth adjacent to such building, which changes the status of the ground floor, shall be considered an alteration.

Sec. 633.6 Allowable Variance.

A variance of ten percent in any required dimension or number in relation to egress, will be permitted in the alteration, or conversion, of existing buildings, as defined in this Section unless full compliance is required under Section 633.2. This variance will not be permitted in the case of ceiling height, headroom, slope of ramps, rise and tread of stairs, nor emergency lighting or appliances.

Sec. 633.7 Doors Projecting Beyond Building Line.

Existing doors swinging out 18 inches beyond building line may remain.

SECTION 634.0 - STAIRWAYS FOR BUILDINGS ALTERED OR CONVERTED

Sections
634.1 Interior Stairways
634.2 Exemption from Enclosure
634.3 Closets in and Under Stairways
634.4 Smokeproof Towers
634.5 Exterior Stairs
634.6 Limitations on Use
634.7 General Requirements for Exterior Stairs
634.8 Construction of Exterior Screened Stairways
634.9 Fire Escapes

Sec. 634.1 Interior Stairways.

(1) Stairways and landings may be accepted if their narrowest point be used to determine the number of units of width above that point.

(2) In the alteration or conversion of buildings erected prior to March 8, 1946, a fireman's gooseneck ladder leading from a fire escape or an interior ladder and scuttle leading to the roof, may be accepted or provided, in lieu of extending the interior stairs to the roof.

(3) Stair installations which do not fully conform to the requirements in Section 603.5 on treads, risers, and landings, will be accepted if approved by the Director.

Sec. 634.2 Exemption from Enclosure.

The following are exempt from the requirement that each stairway shall be completely within an enclosure:

(1) Two-story L-2 buildings converted to L-1 uses having rooming units only for not more than 25 persons above the main floor and having a direct, independent, second means of egress from each rooming unit.

(2) Three-story L-2 buildings converted to L-1 uses having rooming units for not more than 15 persons above the main floor and having a direct, independent, second means of egress from each rooming unit.

Sec. 634.3 Closets in and Under Stairways.

Except in two-story buildings, closets installed in non-fire-resistive stair enclosures shall be fire protected on the inside in accordance with the requirements of Section 606.5(2). Openings between the stairway and the closet shall be protected. In fire-resistive stairways, the doors of each such closets shall be protected.

Sec. 634.4 Smokeproof Towers.

(1) Class B stairs, where permitted by occupancy egress requirements, may be used in smokeproof towers.

(2) Where Fire-Resistive construction is not required, except in places of public assembly, the stairs, landings, and platforms within the tower enclosure may be of wood, if tower is protected in accordance with Section 607.3.

Sec. 634.5 Exterior Stairs.

Required exterior stairs shall consist of exterior screened stairways or fire escapes, and shall be constructed of incombustible materials.

Sec. 634.6 Limitations on Use.

(1) Fire escapes shall not be permitted as a required exit on buildings erected after March 8, 1946.

(2) Fire escapes shall not be permitted as required means of egress on any building, regardless of date of erection, that is altered or converted for use as a school, Group F-4A (see exception in Section 629.2(3) for schools in Business Group E buildings) or in any other Group F Assembly buildings, nor on Group M-2 Institutional buildings.

(3) See Section 634.9(7)3. for fire escapes on buildings over five stories in height.

Sec. 634.7 General Requirements for Exterior Stairs.

The following requirements shall apply to all types of exterior stairs.

(1) Plans and Inspection. Two sets of plans containing details of the construction of each stairway or fire escape shall be submitted to and approved by the Director before their erection is started. Plates and nuts forming interior supports for brackets and rails shall not be concealed until inspected and approved by the Director.

(2) Painting and Maintenance. Required exterior stairs and fire escapes shall be painted before and immediately after erection, and shall be painted thereafter as often as necessary to maintain them in proper condition. They shall be kept clear of all encumbrances and obstructions, and shall be promptly cleared of any accumulation of snow or ice.

(3) Proximity of Ducts or Electric Wires. No ventilating, air conditioning or exhaust duct or opening shall open upon nor within 10 feet directly below a required exterior stairs or fire escape, nor shall electric wires, unless enclosed in rigid conduits or as otherwise approved by the D. C. Electrical Code, be directly above nor within 5 feet of such stairs or fire escapes.

(4) Arrangement and Accessibility.

1. Exterior stairs shall be arranged to lead directly to a street or public alley, or to an approved court or open space leading to a street or public alley, and shall extend to the roof of the building they serve, unless otherwise approved by the Director.

2. The location of exterior stairs shall be such that the occupants of the building served by them shall not be required to pass through a stair enclosure to reach them.

3. Where connecting rooms are always rented as a suite, proper access from any room of the suite will be considered sufficient. The Director may require an affidavit to the effect that such rooms are always rented en suite.

4. Drop ladders when in the raised position, and the brackets of platforms, shall be at least 14 feet above alleys, and at least 12 feet above sidewalks and parkings.

5. If the height between the ground level and the lowest platform exceeds 20 feet, an intermediate platform at least 3 feet in length and of width equal to the width of the stairs it serves, shall be provided. Such intermediate platform shall be at least 14 feet high, if above an alley; at least 12 feet high, if above a sidewalk or parking, and at least 7 feet high, if above private property.

Sec. 634.8 Construction of Exterior Screened Stairways.

(1) Anchorage. All supporting bars which are in tension and which are fastened directly to a building shall pass through the wall and be securely fastened to the framework of the building or by other means giving adequate anchorage for the stress carried by the bars.

(2) Stairs. The width, rise, and tread of stairs shall conform to the requirements for Class B interior stairs.

(3) Platforms, Passageways, and Landings. The minimum clear unobstructed width of platforms, passageways, or landings connecting flights of stairs shall not be less than the width of such stairs. Landings at the head and foot of stairs shall have a minimum dimension not less than the required width of the stairs, and shall extend at least 4 inches beyond the jambs of any exit opening thereon. The vertical distance between platforms, passageways, or landings shall not exceed 12 feet.

(4) Headroom. The minimum headroom at all points on platforms, passageways and stairs shall be 6 feet 8 inches, measured vertically.

(5) Enclosure of solid, slotted, or grille construction, not less than 5 feet high, shall be provided for platforms, passageways, landings, and stairs. For stairs, the height of the enclosure shall be measured vertically from the nosings of the stairs. Roofs, with eaves projecting at least 6 inches beyond the enclosures, shall be provided, and shall be extended to cover the stairs leading to the ground level, whether such stairs are fixed or are of the swinging type.

(6) Openings for Access. Access to stairways shall be through doors or casement windors, not less than 30 inches wide and 6 feet 6 inches high, the sills of which are not more than 8 inches above the level of the platform or passageway. Such doors or windows shall be fire-protected in accordance with Article 9, Section 915.0, shall swing in the direction of exit travel and be so arranged that they cannot obstruct exit travel on the stairway.

Sec. 634.9 Fire Escapes.

Fire escapes shall be made of steel or wrought iron. Welding shall conform with the requirements of Article 8, Section 842.0 of this Code.

(1) Material Requirements.

1. Steel shall be of grade conforming with the requirements of Article 8, Section 842.0 of this Code.

2. Wrought iron shall conform with the requirements of specifications for Wrought Iron Rolled Bars, ASTM A207-68.

(2) Design Load. Platforms, stairs, and their supports shall be designed for a live load of not less than 100 lbs. per square foot of horizontal projection.

(3) Width. The minimum clear width of stairs and ladders shall be 20 inches and the minimum clear width of platforms, landings, and passageways, shall be at least the width of the stairs they serve.

(4) Rise.

1. The pitch of stairs, and of drop ladders in the "down" position, shall not exceed 60 degrees.

2. The vertical distance between platforms shall not exceed 14 feet.

3. Risers of stairs shall not exceed 12 inches and treads shall not be less than 5 inches in width.

(5) Drop Ladders. Drop ladders shall be used in all locations where fire escapes are suspended above public space, and may be used in other locations.

(6) Vertical Ladders.

1. Vertical ladders, either of the rigid or of the collapsible type, may not be used in locations where the pitched or horizontal type can be used.

2. Vertical ladders of the collapsible type, in locations where permitted, may be used, if of a type and design approved by the Director.

3. Vertical ladders of the rigid type, where permitted, shall have guide rails arranged to keep the ladders close to the edge of the platforms, and to prevent swaying.

(7) Railings.

1. Each platform, landing, and passageway, shall be provided with railings consisting of at least two rails, the top of which shall be not less than 32 inches high.

2. Railings shall be supported by standards of 1-in. pipe, or equivalent, and shall be of sufficient strength to sustain a horizontal pressure against the top rail of 25 pounds per linear foot.

3. On buildings over 5 stories in height, the railings on those portions of fire escapes above the 5th floor level, shall be enclosed to the height of the top rail with metal slats or grills, or mesh construction.

(8) Details of Construction. The details of construction of fire escapes, not herein specified, shall be as approved by the Director.

(9) Openings for Access.

1. Where a room intervenes between a public corridor or hallway and a fire escape, either the door of the room shall be removed, or an unobstructed passageway leading to the fire escape shall be provided not less than 30 inches wide.

2. Windows may be used as access to fire escapes provided they are not less than 30 inches wide in the clear, 3 feet high and with sill not more than 2-1/2 feet above floor level, unless otherwise approved by the Director.

3. Where a window providing access to a fire escape serves more than two rooms or more than 10 persons, and its sill is more than 18 inches above floor level, one or more steps of equal height shall be provided. Such steps shall be the full width of the window opening and shall have not less than 9-inch treads.

4. For protection of wall openings at fire escapes, see Article 9, Section 929.0.

SECTION 635.0 - EMERGENCY LIGHTINING, SIGNS, AND PROTECTIVE APPLIANCES FOR BUILDINGS ALTERED OR CONVERTED

Sections
635.1 Emergency Lightining and Signs
635.2 Special Protective Appliances

Sec. 635.1 Emergency Lighting and Signs.

(1) The requirements for emergency lighting and signs in connection with exterior screened stairways and fire escapes shall be the same as set forth for other types of exits in Section 613.0 of this Article.

(2) The requirements for lighting other types of exits shall be the same as in Section 613.0 of this Article.

Sec. 635.2 Special Protective Appliances.

The requirements for hand fire extinguishers, fire alarm equipment, standpipes, and automatic sprinklers, or other automatic protection, shall be the same as are specified for new construction in this Code.

SECTION 636.0 - RESIDENTIAL L-1 AND BUSINESS GROUP E OCCUPANCIES FOR BUILDINGS ALTERED OR CONVERTED

Sections
636.1 Stairways

Sec. 636.1 Stairways.

Required stairs for buildings altered or converted for L-1 Residential use of E Business use shall consist of not less than one Class A or B interior stairway or smokeproof tower. If additional means of egress are required, they may be exterior screened stairways. Fire escapes may be permitted if the building was, erected prior to March 8, 1946.

SECTION 637.0 - STORAGE B, MERCANTILE C, AND INDUSTRIAL D OCCUPANCIES FOR BUILDINGS ALTERED OR CONVERTED

Sections
637.1 Stairways
637.2 Storage or Parking Garages

Sec. 637.1 Stairways.

(1) In buildings not more than five stories in height, that are altered or converted for B Storage, C Mercantile, or D Industrial use, there shall be not less than one Class A or Class B interior stairway, or smokeproof tower. If additional means of egress are required, they may be exterior screened stairways. Fire escapes may be permitted if the building was erected prior to March 8, 1946.

(2) In such buildings over five stories in height, there shall be at least one Class B interior stairway, or smokeproof tower. If fire escapes are already installed they may be used as additional means of egress subject to the requirements of Section 634.9(7)3..

(3) In such buildings over five stories in height, where fire escapes are not already installed, there shall be at least one Class B interior stairway or smokeproof tower. If additional means of egress are required, they may be Class B interior stairways, smokeproof towers, or exterior screened stairways.

Sec. 637.2 Storage or Parking Garages.

The requirements for buildings altered or converted to parking or storage garages for five or more vehicles, shall be the same as under Section 637.1 above, except that ramps without enclosures may be built in such buildings.

SECTION 638.0 - HIGH HAZARD A OCCUPANCIES FOR BUILDINGS ALTERED OR CONVERTED

Sections
638.1 General Requirements.

Sec. 638.1 General Requirements.

For buildings altered or converted to Group A High Hazard uses, the requirements for means of egress and related facilities shall be the same as for new construction under applicable provisions of Sections 601.0 through 632.8 of this Article.

SECTION 639.0 - ASSEMBLY GROUP F BUILDINGS FOR BUILDINGS ALTERED OR CONVERTED

Sections
639.1 Group F-1, F-2, F-3, and F-4B Assembly Buildings
639.2 Group F-4A Assembly Buildings

Sec. 639.1 Group F-1, F-2, F-3, and F-4B Assembly Buildings.

For buildings altered or converted to Group F-1, F-2, F-3, or F-4B Assembly use, the requirements for means of egress and related facilities shall be the same as for new construction under applicable provisions of Sections 601.0 to 632.8.

Sec. 639.2 Group F-4A Assembly Buildings.

(1) Buildings not over Three Stories. Buildings not more than three stories in height, nor more than 5,000 square feet per floor in area, erected prior to March 8, 1946, which are altered or converted to F-4A Assembly or similar use, shall have not less than two means of egress, one of which shall be an interior enclosed Class A or Class B stairway located next to an exterior wall. This stairway shall have a window to the outside at each story, except the story in which a door discharges from the stairs directly to the outside. Exterior stairways, if constituting an additional required means of egress, shall comply with no lesser requirements than for exterior screened stairways in Sections 634.7 and 634.8.

(2) Buildings over Three Stories. Buildings more than three stories in height, or having more than 5,000 square feet of area per floor, which are altered or converted to Group F-4A Assembly use, shall be required to conform with all applicable provisions of Sections 601.0 through 632.8 of this Article, except as provided under paragraph (3) below.

(3) Schools in E Business Buildings. Buildings or portions thereof, erected prior to September 16, 1947, which meet all the requirements for E Business use, may be occupied for school uses without further requirements when approved by the Director, provided the following conditions are met:

1. The students be ambulatory persons 18 years of age or over.

2. The population shall not exceed that permitted for E Business purposes.

3. The use of the building for school purposes will not create any hazard exceeding that incident to normal business use.

4. The floors are designed and constructed to support the maximum live loads, including students and such shop, laboratory, or other school equipment as specified in the application for certificate of occupancy.

5. Exit widths shall be not less than those computed on the basis of 60 persons per unit of width per floor occupied for school purposes.

SECTION 640.0 - EXISTING BUILDINGS

Sections
640.1 Statement of Intent and Administrative Procedures
640.2 Applicability
640.3 Board of Appeals and Review

Sec. 640.1 Statement of Intent and Administrative Procedures.

(1) Statement of Intent. It is the intent of Sections 640.0 through 649.0 of this Article to provide a reasonable amount of protection to occupants of existing buildings so that their lives will be safeguarded against the dangers of fire, smoke and panic. It is not the intent of these Sections to impose exscessive requirements not commensurate with the benefits derived.

(2) Date of Violation. As provided in Means of Egress Act of December 24, 1942, (Public Law 838, 77th Congress) the text of which is set forth in the Building Code Manual, the Commissioner of the District of Columbia hereby authorizes the Director of the Department of Economic Development, or his representative, to issue notices directing the owner, as defined in said Act, to comply with those items not meeting the requirements of Sections 640.0 through 649.0 of this Article as set forth in said notice, not later than ninety days from the date of service of the notice in the manner specified in the Act, and in addition thereto the Director may when in his opinion, conditions justify, authorize extension or extensions to said notice. Upon the expiration of the time set forth in said notice or any extension or extensions thereto and the failure of the owner to comply with the said notice, it shall be deemed at that date that any further use and/or occupancy of the building is not in compliance with these regulations and thereafter following the expiration of a thirty-day notice in writing from the Director of the Department of Economic Development, served in the manner prescribed in said Act, it shall be a violation of these regulations for the owner to use the building or for any person to occupy the building.

(3) Penalties and Restrictions. As provided in the Means of Egress Act of December 24, 1942, any owner who uses or permits the occupancy of his building in violation of these regulations, as defined in this Section, shall be subject to the following penalties or restrictions:

1. Upon conviction of a violation of these regulations, the owner shall be punished by fine of not less than $10.00 nor more than $100.00 per day for each and every day such violation exists; and

2. Without application to court, the Director of the Department of Economic Development is empowered to cause such construction and installations of those items set forth in the notice provided in this Section, and the Commissioner is authorized to assess the costs thereof as a tax against the building on which they are erected and the ground on which the building stands, said assessment to bear interest at the rate and be collected in the manner provided in Section 5 of the Act entitled "An Act Relating to the Levying and Collecting of Taxes and Assessments, and for other Purposes," and approved June 25, 1938; and

3. Upon petition of the District of Columbia filed by the Commissioner in the United States District Court for the District of Columbia, the said Court may issue an injunction to restrain the use or occupation of the building, and the same shall apply to the owner, lessee or occupant thereof.

Sec. 640.2 Applicability.

(1) These requirements shall apply to the following:

1. All existing Institutional H buildings regardless of height or date of erection.

2. All Assembly F buildings of any height erected prior to March 8, 1946, or subsequently erected under permits applied for prior to that date; and

3. All other buildings erected prior to March 8, 1946, or subsequently erected under permits applied for prior to that date, which are three or more stories or over thirty feet in height.

4. The requirements of 1. 2. and 3. above, do not apply to Residential L-2 buildings.

(2) The specific provisions in Sections 640.0 through 649.0 of this Article are applicable to any existing building coming within the limits defined under (1) above.

(3) Where the application of the requirements of Sections 640.0 through 649.0 would result in exceptional or undue hardship by reason of excessive structural or mechanical difficulties or impracticability of bringing the premises affected into compliance, a variance may be granted by the Director only where, and to the extent, necessary to ameliorate such exceptional or undue hardship; and only when compensating factors are present which, in his opinion, give adequate protection to the public safety, or which will be provided and installed and which will give adequate protection to the public safety, and such variance can be granted without impairing the intent and purposes of Section 640.0 through 649.0.

(4) The Director, in his discretion, may refer requests for variances, without final decision, to the Board of Appeals and Review for the latters' action.

(5) The owner of any premises subject to the provisions of Sections 640.0 through 649.0 who is adversely affected by a determination made by the Director under the authority of Sections 640.0 through 649.0 may file an appeal in writing with the Board of Appeals and Review. Such appeal shall state the error alleged to be contained in any decision, determination or refusal adversely affecting such owner, and shall be filed within the period specified in the notice of violation for compliance therewith. (See Section 640.3.)

Sec. 640.3 Board of Appeals and Review

In applying the provisions of Sections 640.0 through 649.0 and related structural requirements, the Board of Appeals and Review may grant a variance from the application of Sections 640.0 through 649.0, if such Board shall find that the full performance of the requirements of Sections 640.0 through 649.0 and related structural requirements would result in undue hardship by reason of excessive structural or mechanical difficulty or impracticability of bringing the premises affected into full compliance with the requirements of Sections 640.0 through 649.0; provided that a variance will be granted only where, and to the extent, necessary to ameliorate such exceptional and undue hardship and only when the compensating factors are present which give adequate protection to the public safety; or which will be provided and installed and which give adequate protection to the public safety; and such variance can be granted without impairing the intent and purposes of Sections 640.0 through 649.0. Any decision of the Board of Appeals and Review made pursuant to this Section shall be final.

SECTION 641.0 - GENERAL EXIT AND PROTECTION REQUIREMENTS FOR EXISTING BUILDINGS

Sections

641.1 Room Exits
641.2 Permissible Roof Exits
641.3 Boiler Room Exits
641.4 General Stair Requirements
641.5 Stairs to Roof
641.6 Interior Stairways and All Vertical Shafts
641.7 Exterior Stairs
641.8 Stairway Enclosures
641.9 Existing Wood Fire Escapes where Fire Escapes are Required
641.10 Enclosure of Shafts
641.11 Doorways and Doors
641.12 Exit Corridors
641.13 Required Protection

Sec. 641.1 Room Exits.

The number and location of room exits shall be as specified hereinafter except that where exceptional hardship could result, the Director may modify the requirements with the concurrence of the Fire Chief.

Sec. 641.2 Permissible Roof Exits.

At least two exits shall be provided if the occupant capacity on the roof is more than 100 persons. Capacity shall be prominently posted.

Sec. 641.3 Boiler Room Exits.

If more than one exit is required as per § 601.5, then a permanent steel ladder or circular metal stairway with rungs or treads not less than 18 inches long may serve as one of the required exits from boiler rooms.

Sec. 641.4 General Stair Requirements.

Existing stairs, both interior and exterior stairs and fire escapes, shall be accepted with no change provided that the specific provisions of Sections 640.0 through 649.0 are satisfied.

Sec. 641.5 Stairs to Roof.

In lieu of the required extension of an interior stairway to the roof, a permanent steel ladder not less than 22 inches wide and scuttle not less than 2 feet by 3 feet, or extension to the roof of an exterior screened stairway or fire escape

ladder protected as required in § 929.2 of Article 9 shall be provided. See also Table 101 of this Article.

Sec. 641.6 Interior Stairways and All Vertical Shafts.

(1) Stairway installations which do not conform to the requirements of Section 603.5 on treads, risers, landings, and tread surfacing, and to Section 603.6 on vertical rise, may be approved by the Director if considered safe by him for the particular locations and use.

(2) Closets may be permitted to remain under stairways if fire-protected as required in Section 634.3.

(3) Stairs in smoke-proof towers may be Class B if having the width required for the location, and stairs, landings, and platforms, within the tower may be of wood for the conditions allowed in Section 634.4.

(4) In these requirements, a smoke-proof tower shall be considered the equivalent of and may be substituted for an enclosed interior stairway if the requirements of maximum length of travel are fulfilled.

(5) The limitations on dead ends of corridors beyond the entrance to stairways or other exits shall not apply.

(6) Moving stairs shall be accepted as providing part of the required exit width to the extent permitted in Section 605.0 of this Article.

(7) All interior stairways, as defined in this Code, shall have at least one handrail or balustrade.

Sec. 641.71 Exterior Stairs.

(1) Exterior screened stairs and fire escapes where permitted under occupancy egress requirements, shall conform with the requirements of Sections 634.7, 634.8 and 634.9 except that if not conforming to these requirements, the Director may approve them if considered safe by him for the particular locations and use, and further provided that previously established access to existing fire escapes through existing rooms by means of a door which has a glass panel that can be broken to gain entrance will be continued to be allowed.

(2) Protection of wall openings at exterior stairways and fire escapes shall conform to the requirements of Section 929.2 of Article 9.

Sec. 641.8 Stairway Enclosures.

The requirement of Section 606.1, that the enclosure shall be so arranged that the line of travel shall be completely within the enclosure, may be modified where allowed by the occupancy egress requirements for existing buildings, Sections 643.0 through 648.0 of this Article, to permit enclosures that serve primarily to prevent communication of fire, smoke, and heated gases from story to story.

(1) For this purpose, the stairway may be enclosed in alternate floors.

(2) Partitions may be placed across the ends of corridors adjacent to stairways.

(3) Stairways shall be enclosed in the attic space.

(4) Enclosure construction shall conform to the requirements of Article 9, Section 909.0 except that the fire-resistance rating need not exceed 3/4 hour incombustible in buildings of Type 1 or Type 2 construction nor 3/4 hour combustible in buildings of Type 3 or 4 construction.

(5) Doors into stairway enclosures from utility rooms, store rooms, commercial kitchens, shop rooms, and other similar or more hazardous uses shall be of not less than unlabeled hollow metal or kalomein construction and shall be set in steel bucks. Doors into stairway enclosures from other locations shall be equivalent to 1-3/4 inch thick solid wood core construction or shall be covered with 26 gage metal on the side leading into the stairway enclosure. Existing wood bucks shall be covered with 26 gage metal on at least the side leading into the stairway enclosure or shall be replaced by steel bucks. All doors leading into stairway enclosures shall be equipped with approved closers.

(6) Enclosures for moving stairs shall conform to the requirements of Section 606.0 of this Article.

(7) Each stairway required to be either fully or partly enclosed shall be provided with ventilation as required for new buildings. See Article 5.

Sec. 641.9 Existing Wood Fire Escapes where Fire Escapes are Required.

All wood fire escapes shall be removed and in lieu thereof there shall be erected a standard fire escape which conforms to the requirements of this Code, or other means of egress shall be provided conforming with the requirements for existing buildings.

Sec. 641.10 Enclosure of Shafts.

(1) Elevator shafts and pipe and vent shafts over 10 square feet in area shall be enclosed with constructions as required in Section 909.0 of Article 9 except that the fire-resistance rating need not exceed one hour in buildings of Type 1 Fire-Resistive construction nor 3/4 hour in buildings of Types 2, 3, or 4 construction. Openings in enclosures shall be protected as required in Section 914.0 of Article 9, except that doors of elevator shafts may be 1-1/2 hours Class B, or 1/1-2 hours BOCA labeled, and doors of other shafts shall conform with the requirements for K or better.

(2) Shafts of 10 square feet or less area shall be enclosed to be smoke-tight in a manner satisfactory to the Director. Doors, frames and trim, if of wood, shall be covered on the shaft side with not less than 26 gage metal.

Sec. 641.11 Doorways and Doors.

The requirements for doorways, doors, and door hardware shall be as required for new construction in Sections 611.1 through 611.7, 617.5(1), 626.8 and Sections 910.0 through 914.0 of Article 9 except as herein provided:

(1) Swinging Doors.

1. No landing need be provided where a door opens on a flight of steps, Section 611.2(8), but the first tread of the stair shall be on a level not more than one inch below the threshold.

2. Existing exit doors required to swing outward may swing beyond the building line but not beyond the outer line of adjoining show windows, bay windows or other authorized projections, nor more than 18 inches where there are no projections.

3. Unless otherwise provided, no change need be made in existing doorways and doors from rooms to public corridors, if conforming from the standpoint of location, number, units of width, headroom, openability, fire resistivity and swing, with the requirements for new construction, except that where such doors do not comply with the requirements for fire resistivity they shall be as fire-resistant as 1-3/4 inch solid wood core door, or shall be covered with at least 26 gage metal on the room side as shall the door jambs, or both sides of the doors, jambs and trim shall receive a coating of an approved paint which will provide a fire-retardant flame spread rating. Such doors from the storage and utility rooms shall be covered on the room side with at least 26 gage metal. In L-1 buildings, undercut doors or louvres with approved fire dampers may be permitted in transom space above doors, in walls, or in doors from dwelling units to public corridors where existing air conditioning systems require louvres for return air through corridor. Existing slat and/or louvred doors in L-1 Residential Buildings where fresh air is supplied to the dwelling units from the public corridor may remain. All existing vertical ducts must have approved fire dampers. In addition, smoke alarms shall be installed in each and every duct returning air from a floor to the circulating fan such that the alarms will turn the circulating fan off. Fire dampers shall be in accordance with Section 1109.31 of Article 11.

(2) Revolving Doors. Existing revolving doors may be permitted to remain in use and serve as a means of egress, provided that they are not less than 5 feet 6 inches in diameter and that the width of opening is not less than 3 feet 0 inches.

(3) Approval and Labels. Existing doors in locations requiring labeled openings may be approved by the Director, provided that when they were originally installed, these types of doors were accepted and approved as meeting the requirements for labeled openings.

Sec. 641.12 Exit Corridors.

In buildings of Type 1 and 2 construction the walls, floor system, and ceilings of exit corridors shall be of incombustible construction with a rating of not less than 1 hour for Type 1 nor 3/4 hour for Type 2 construction. In buildings of Type 3 or 4 construction only, the walls, floor system, and ceilings of exit corridors may be of combustible construction, but shall have a rating of not less than 3/4 hour. For purposes of this section only, existing wood lath and plaster may be removed on the corridor side of partitions of Type 3 or 4 buildings, the stud spaces fully filled with mineral wool batt insulation, and the plaster replaced by an approved 3/4 hour material. Doors from utility rooms, store rooms, kitchens, shop rooms and other similar or more hazardous uses shall be of not less than unlabelled hollow metal or kalomein construction and shall be set in steel bucks with approved closers. Doors from other rooms shall be equivalent to 1-3/4 inch thick solid wood core construction or shall be covered with 26 gage metal on the room side and shall be equipped with approved closers. Existing wood bucks shall be covered with 26 gage metal on the room side or shall be replaced by steel bucks. Where in the judgment of the Director it is determined that existing low hazard uses adjacent to

lobbies used as exit corridors are of such nature as to meet the intent of Sections 617.5, 617.9 and 620.6, when applied to Business E and L-1 Residential buildings the relaxation in the requirements permitted by these sections may be applied.

Sec. 641.13 Required Protection.

(1) Main Floor. Required protection of the main floor shall be 3/4 hour.

(2) Transoms. All transoms over door openings between rooms and public corridors, exit corridors or lobbies in all buildings of Group A, F, H and L-1 occupancies shall be made unopenable and glazed with 1/4" thick wire glass or covered with 26 gage metal or 3/8" thick gypsum board.

SECTION 642.0 - EXIT LIGHTS, SIGNS AND SPECIAL PROTECTIVE EQUIPMENT FOR EXISTING BUILDINGS

Sections

642.1 Exit Lights and Signs
642.2 Automatic Sprinkler Equipment
642.3 Fire Extinguishers
642.4 Fire Alarm Equipment
642.5 Standpipe Systems

Sec. 642.1 Exit Lights and Signs.

Existing buildings shall conform with the requirements of Section 613.0 of this Article on exit lights and signs, as modified by occupancy egress requirements for new buildings, except that in L-1 Residential occupancy buildings where accommodations are provided above the main floor for not more than 15 persons, emergency lighting appliances shall not be required, provided that the stairway is enclosed or that there is an open stairway and an independent second exit from every room.

Sec. 642.2 Automatic Sprinkler Equipment.

(1) Automatic sprinklers shall be provided only as required by occupancy egress requirements for existing buildings, and required installations shall conform with the requirements of Sections 1200.0 and 1201.0 of Article 12.

(2) Existing automatic sprinkler installations shall be considered acceptable if conforming substantially with generally accepted requirements when installed.

Sec. 642.3 Fire Extinguishers.

Fire extinguishers shall be provided and conform with the requirements for new construction under Article 12, Section 1202.0, except as exempted under the same conditions as for emergency lighting in Section 642.1, and as further provided in Section 642.5(4).

Sec. 642.4 Fire Alarm Equipment.

Fire alarm equipment shall be provided as required by Section 1203.1 of Article 12 for new construction, except as exempted under the same conditions as for emergency lighting in Section 642.1.

Sec. 642.5 Standpipe Systems.

(1) No new standpipe systems or additions to such systems will be required in existing buildings.

(2) In buildings six stories or more in height, any existing standpipe system having pumper connection for use by the Fire Department shall remain, in use, provided, that if the standpipes are found to be nonconforming in strength, hose thread, and similar essential details as determined by the Fire Chief, they shall be made conforming.

(3) In buildings less than six stories in height, any existing nonconforming standpipe system having pumper connection for use by the Fire Department, which upon tests made in the presence of the Fire Chief, is found to be of inadequate strength to serve the building shall be made to conform or shall be removed or capped.

(4) Standpipes for small hose without pumper connection which are used in lieu of fire extinguishers shall be continued in use if pressure and flow test made at the top outlets indicate adequacy for the location. If found inadequate, fire extinguishers shall be provided, or means shall be provided to increase the water pressure or supply, or the height of the standpipes shall be cut to the level where they are indicated as adequate, such tests and determinations to meet the requirements of and be made in the presence of the Fire Chief.

SECTION 643.0 - RESIDENTIAL L-1 AND BUSINESS E OCCUPANCIES FOR EXISTING BUILDINGS

Sections
643.1 Width of Stairways
643.2 Single Stairway
643.3 Type and Enclosure of Stairways
643.4 Egress from Stairs

Sec. 643.1 Width of Stairways.

Stairways may be Class A, B or C. See Section 604.1.

Sec. 643.2 Single Stairway.

Three story and higher buildings shall have not less than two interior stairways, or one interior stairway and a smoke-proof tower or fire escape, from each egress area (Section 601.1), except that one stairway will be permitted under the conditions set forth in Table 100 for L-1 Buildings and Table 101 for Business E Buildings.

Sec. 643.3 Type and Enclosure of Stairways.

In requirements under this Section, no distinction from the standpoint of enclosure requirements is made between required interior stairways and those not required, except as provided for Business E buildings in Section 606.3 and Section 643.2 and for Residential L-1 buildings in Section 643.2. The requirements for stairs in Business E and Residential L-1 buildings requiring more than one means of egress shall be in accordance with Table 102 and Table 103 respectively.

Sec. 643.4 Egress from Stairs.

Not less than one required exit stairway shall discharge directly to the outside or to an exit corridor leading thereto. The remaining stairways may discharge through a lobby or foyer on the main floor, provided adjacent occupancies are cut off from such lobby or foyer as provided in Sections 617.5 and 620.6.

SECTION 644.0 - INSTITUTIONAL GROUP H OCCUPANCIES FOR EXISTING BUILDINGS

Sections
644.1 General Requirements
644.2 Exit Requirements

Sec. 644.1 General Requirements.

(1) Fire Protective Features. All buildings of Group H Occupancy shall be required to be fully sprinklered and shall have stairways of a width and design approved by the Director, except those of Type 1 or 2A construction, or those of Type 2B, 3A, 3B, or 3C construction wherein persons are housed on the first floor only, if the entrance to such first floor is at a grade or within 6 feet of grade, or those buildings used as day nurseries in which less than 15 fully ambulatory children are accommodated on the first floor or first and second floors only. All buildings of Type 4 construction used for Group H occupancy, regardless of the number of stories, shall be fully sprinklered. Where other compensating fire protective features or egress features, or fire protective features and egress features, are provided in combination with the consideration of the number of occupants and the height of the building, a variance consistent with the requirements set forth in Section 640.2(3), (4) and (5) may be permitted, and if such variance is granted such building shall not be required to be fully sprinklered. Where buildings are required to be fully sprinklered, the sprinkler system shall be indirectly connected to D. C. Fire Alarm Headquarters through a private central office, or the fire alarm system shall be directly connected to the D. C. Fire Alarm Headquarters, or there shall be provided at least one non-coin operated public telephone in such a location as to be readily accessible at all times. The Director and the Fire Chief shall approve the location of such telephone, rules limiting the use thereof, and such signs or placards as are found to be necessary to properly explain the sending of emergency messages thereby.

(2) Buildings which are fully sprinklered will be excused from:

1. Rearranging the required means of egress so that they open directly to street or public alley or to an open air or fire resistive passage leading thereto.

2. Providing the second approved means of egress for each room or suite of rooms on all floors.

3. Providing access to the roof.

4. Fire protecting corridor partitions and ceilings.

5. Providing self-closing fire doors between rooms and exit corridors or passages.

6. Providing fire doors between rooms and public corridors.

7. Terminating basement stairs in proper enclosure.

8. Fire-protecting entire basement ceiling.

9. Removing all non-conforming partitions from the building.

Sec. 644.2 Exit Requirements.

(1) Institutional H-1 Buildings. The egress requirements for existing H-1 Institutional buildings shall comply, as far as practicable, with the requirements for new construction as in Section 619.1 of this Article.

1. Stairways. Stairways shall be enclosed, except that in those buildings where the surveillance of the occupants is a requisite or where there are to be found other special operating conditions affecting the restraint or protection of occupants, or where there are present other compensating factors as set forth in Section 640.2(3), a variance to allow an open stairway will be considered.

2. Egress Plans and Certification. The Director may require a plan and description of the exit facilities provided, and a certificate of their adequacy, signed by the responsible official in charge of the occupancy.

(2) Institutional H-2 Buildings.

1. Number and Type of Exits. Except as exempted under Section 644.1(2), or where the total number of occupants does not exceed 15 (in which case the Director may, with the concurrence of the Fire Chief, permit but one exit), there shall be not less than two exits of the following types:

a. Horizontal exits.
b. Doors leading directly to the outside of the buildings.
c. Enclosed ramps.
d. Enclosed or partly enclosed interior stairways.
e. For special conditions, as described hereinafter, exterior screened stairways.

2. Enclosure of Stairways. The requirements for stairways, whether partly or fully enclosed, shall be in accordance with Section 641.8. All stairways shall be fully enclosed, except as follows:

a. Stairways not serving as required means of egress may be partly enclosed.
b. In buildings of Type 1 or 2A construction, of any height, stairways serving as required means of egress may be partly enclosed when used in conjunction with two or more fully enclosed stairways, horizontal exits, or ramps, the travel to which may pass by but not through the partial enclosure.
c. In buildings of Type 1 or 2A construction, not over three stories high, stairways serving as required means of egress may be partly enclosed when used in conjunction with at least one fully enclosed stairway, exterior screened stairs, horizontal exit, or ramp, the travel to which may pass by but not through the partial enclosure.
d. In buildings required to be fully sprinklered, partly enclosed stairways will be permitted.
e. In buildings wherein the use is limited to the first floor, or where the building is used as a day nursery where less than 15 fully ambulatory children are accommodated on the first floor or first and second floors, a partial enclosure shall be provided in the first or second stories.

3. Exterior Screened Stairway. In buildings not over four stories high, an exterior screened stairway may serve the purpose of one enclosed stairway, ramp, or horizontal exit required for new construction.

SECTION 645.0 - INDUSTRIAL GROUP D AND MERCANTILE GROUP C OCCUPANCIES FOR EXISTING BUILDINGS

Sections
645.1 Industrial Group D Occupancies
645.2 Mercantile Group C Occupancies

Sec. 645.1 Industrial Group D Occupancies.

(1) Type and Enclosure of Stairways.

1. An existing building three or four stories in height if of Type 3 construction, or not over five stories in height if of Type 1 or Type 2A construction, may be served by one or more stairways, partly enclosed per Section 641.8 and one or more exterior screened stairways of fire escapes, the number of interior stairways depending on the required exit width, and this number

as well as that of exterior stairways, depending also in the allowed maximum travel to an exit. (See Sections 621.3 and 622.3.)

2. If the building is equipped throughout with an automatic sprinkler system, the height limitation under 1. above shall not apply.

3. Buildings of any height in which two or more enclosed stairways or smokeproof towers are required for new construction may be served by one fully enclosed stairway, in conjunction with one or more stairways partly enclosed per Section 641.8, or one or more exterior screened stairways or fire escapes.

Sec. 645.2 Mercantile Group C Occupancies.

(1) Type and Enclosure of Stairways.

1. Buildings three stories in height of Type 3 construction, or three or more stories in height of Type 1 or Type 2A construction, shall have not less than one fully enclosed stairway in conjunction with one or more exterior screened stairways or fire escapes. All stairways shall be fully or partly enclosed except as exempted from Group C occupancy buildings in Section 606.3.

2. If a building is other than Type 4 construction and is equipped throughout with a fully automatic sprinkler system, the height limitations under 1. above, shall not apply, and in addition the stairways may be partly enclosed.

(2) Egress from Stairways. Not less than one requires exit stairway shall discharge directly to the outside or to an exit corridor leading thereto. The remaining stairways may discharge through a lobby or foyer on the main floor, provided such lobby or foyer is separated from the remainder of the floor. See Section 622.6(2).

SECTION 646.0 - STORAGE GROUP B OCCUPANCIES FOR EXISTING BUILDINGS

Sections
646.1 Partly Enclosed Stairways
646.2 One Fully Enclosed Stairway
646.3 Parking and Storage Garages

Sec. 646.1 Partly Enclosed Stairways.

(1) A storage building three or four stories high if of Type 3 construction, or not over five stories high if of Type 1 or Type 2A construction, may be served by one or more stairways partly enclosed per Section 641.8 in conjunction with one or more exterior screened stairways or fire escapes.

(2) If the building is equipped throughout with an automatic sprinkler system, the requirements under (1) above, either on the height limitation of the building or on the requirements for exterior stairways, shall be waived.

Sec. 646.2 One Fully Enclosed Stairway.

(1) A storage building of any height may be served by one fully enclosed stairway in conjunction with one or more partly enclosed stairways, or one or more exterior screened stairways or fire escapes.

(2) If the building is equipped throughout with an automatic sprinkler system, the requirements for exterior stairways under (1) above shall be waived.

Sec. 646.3 Parking and Storage Garages.

A parking or storage garage, the use of which has not been changed, and the lines of travel of the original stairways which have not been altered, will not be required to provide additional means of egress, if it has not less than one fully enclosed stairway.

SECTION 647.0 - HIGH HAZARD GROUP A OCCUPANCIES FOR EXISTING BUILDINGS

Sections
647.1 Width and Location of Exits
647.2 Enclosure of Stairways
647.3 Exterior Stairways

Sec. 647.1 Width and Location of Exits.

No change shall be required in width of exits when one unit of exit width or more for each 3,000 sq. ft. of the largest floor area served is provided.

The distance to exits may be 100 feet in buildings protected with an automatic sprinkler system and 60 feet in buildings not thus protected.

Sec. 647.2 Enclosure of Stairways.

Stairways not serving as a required means of egress may be partly enclosed per Section 641.8.

Sec. 647.3 Exterior Stairways.

Exterior stairways may be exterior screened stairways or fire escapes.

SECTION 648.0 - ASSEMBLY GROUP F OCCUPANCIES FOR EXISTING BUILDINGS

Sections
648.1 Exit Layout
648.2 Emergency Stairways
648.3 Grandstands, Stadiums, Reviewing Stands, and Other Outdoor Assembly Places.
648.4 Outside Stairways

Sec. 648.1 Exit Layout.

Any layout of exit facilities, including exit widths, seating arrangements, aisles, ramps, and steps, may be accepted by the Director, with the concurrence of the Fire Chief, subject to such modification as in their judgment are essential for safety.

Sec. 648.2 Emergency Stairways.

Emergency stairways may be either fully enclosed interior stairways, smokeproof towers, or exterior screened stairways. Required interior stairway enclosures shall be in accordance with Section 641.8 of this Article.

Sec. 648.3 Grandstands, Stadiums, Reviewing Stands, and Other Outdoor Assembly Places.

Egress stairways and ramps need not be enclosed irrespective of the height of the structure, if the construction is of Type 1 or Type 2 with solid floor or deck.

Sec. 648.4 Outside Stairways.

Outside stairways need not conform with the requirements of Section 612.0 of this Article, except for railings under Section 612.1(5).

SECTION 649.0 - MULTIPLE OCCUPANCIES FOR EXISTING BUILDINGS

Sections
649.1 Multiple Occupancy

Multiple occupancy separations in existing buildings shall be accepted if being constructed of, or having a fire resistance rating equivalent to a double wall of metal lath and plaster. Any layout of exit facilities, including exit widths, may be accepted by the Director with the concurrence of the Fire Chief, subject to such modifications as in their judgment are essential for safety.

SECTION 650.0 - BUILDINGS AFFECTED BY THE TEMPORARY REGULATIONS

Sections
650.1 Applicability

Sec. 650.1 Applicability.

(1) Those buildings for which certificates of occupancy were issued under the authority of Commissioners' Order dated May 28, 1943, E. D. 210583-54 and Commissioners' Order dated November 24, 1943, E. D. 236470-27 known as the "Temporary Regulations" for the war emergency and wherein the certificate of occupancy is desired to be continued, shall meet the following:

1. All buildings, three or more stories in height, shall meet all applicable provisions of Sections 640.0 through 649.0 of this Article.

2. All buildings, two stories in height, having rooming or dwelling units for more than 25 persons above the main floor shall, in addition to a direct, independent second means of egress from each such unit, have a fully or partially enclosed stairway accessible to each rooming or dwelling unit and shall meet the other applicable provisions of Sections 640.0 through 649.0 of this Article pertaining to L-1 occupancies.

3. All buildings, two stories in height, having rooming or dwelling units for not more than 25 persons above the main floor and having a direct, independent second means of egress from each rooming or dwelling unit will not be required to have a fully enclosed stairway, but all other applicable provisions of Sections 640.0 through 649.0 of this Article pertaining to L-1 occupancies shall apply.

SECTION 929.0 - BUILDINGS ALTERED OR CONVERTED

Sections
929.1 Fire-Resistive Doors, Windows, and Shutters
929.2 Openings on Exterior Stairs or Fire Escapes

Sec. 929.1 Fire-Resistive Doors, Windows, and Shutters.

When buildings are altered or converted the requirements for fire-resistive doors, windows, and shutters shall be the same as for new construction. The Director may allow minor variations where the required degree of fire safety is substantially obtained.

Sec. 929.2 Openings on Exterior Stairs or Fire Escapes.

Where exterior screened stairs or fire-escapes are approved in connection with the alteration or conversion of buildings, the windows and doors opening onto them, or within ten feet under them shall be protected in accordance with the following:

929.21 Double-hung or single-hung windows shall have the upper half of the sash glazed with wired glass, 1/4 inch thick, and shall be properly counterbalanced or shall be permanently fixed.

929.22 Casement windows shall be glazed with wired glass 1/4 inch thick.

929.23 Doors shall be covered on the inside with metal not thinner than 26 gage, and if glazed, shall be glazed with 1/4 inch wired glass; jambs and trim may be unprotected on the ground floor.

929.24 Show windows on the ground floor either projecting or in the walls of the building, need not be protected.

SECTION 10008.0 - EXISTING INSTALLATIONS

Sections
1008.1 General Requirements
1008.2 Correction of Deficiencies

Sec. 1008.1 General Requirements

When new equipment is to be connected to an existing masonry chimney which does not have an approved lining in good condition, an approved lining shall be installed. This may consist of Type B gas vent, U.L. approved chimney, or other lining of the type required for the equipment to be connected or may be made of approved stainless steel welded throughout.

Sec. 1008.2 Correction of Deficiencies

Correction of unsafe conditions due to defective chimney, flue, fireplace or incinerator installations shall be required.

APPENDIX 7

San Francisco, California

SAN FRANCISCO, CALIFORNIA

Code Requirements

San Francisco has a local code organized in the format of the Uniform Building Code. The 25-50% Rule and the general change of use regulation are not included in the code. The general application of the code to an existing building is contained in Sections 104.A through 108 and Table 5.1 for change in occupancy. Section 104.A specifically references the housing code. Other major provisions are:

Section 104.B - Structural Alteration Work

Provides that new work and any part which becomes an integral part of or affected by the work shall meet the code for vertical loads. Generally defined on a floor-by-floor basis, and requires improvement of floor above and below, if needed to prevent adverse affect.

The entire building must meet lateral force requirements (104.F) when more than 30% (cumulative since the building was built) of the above grade area has been involved in substantial structural alteration work.

Section 104.C - Architectural Alteration Work

Provides that all new or directly affected work shall meet code requirements. When 75% of interior walls or partitions on a floor as measured by lineal footage are removed or added to a floor, then all interior walls or partitions on that floor shall comply with the code. If substantially all of the interior walls, ceilings, etc. of a building are involved in extensive change, then the building as a whole must comply with lateral force requirements.

Section 104.D - Additions

Provides for specific code compliance requirements for lateral force, fire protection, egress, height and area.

Section 104.E - Change of Occupancy

Table 5.1 of this section shows those changes of use which require less than or full compliance with the code. The Table is a matrix of occupancies. Depending upon the use to which the building is being converted, and based on relative hazard, it may be required to fully meet new construction standards, or it may be required to meet one of two levels of essential occupant and fire safety rules specified.

San Francisco also has a housing code which contains certain retroactive provisions.

Operation of the Codes

Essentially, San Francisco inspects existing buildings to the housing code (for residential occupancies) and to the codes under which they were erected. A field inspection manual for residential occupancies is used which contains specific tolerances and guidelines for inspectors on enforcement requirements. When new work is required, the new work must meet the code as specified in 104.B and 104.C. Seismic requirements are triggered by the 30% and 75% Rule in 104.B and 104.C. These percentages, however, are based upon the percentage of the building affected, rather than investment or cost. Allowable changes in occupancy and degree of code compliance required is governed by the matrix of Table 5.1.

ARTICLE 1

TITLE AND SCOPE

Sec. 101. Title. This Chapter, known as the "Building Code," is a portion of the San Francisco Municipal Code, and will be referred to in this Chapter as "this Code."

Sec. 102. Purpose. The purpose of this Code is to provide minimum standards to safeguard life and limb, health, property, and public welfare by regulating and controlling the design, construction, alteration, repairing, maintenance, use, moving and removal of buildings or other structures or parts thereof erected or to be erected in San Francisco; and the safe use of such buildings, structures and land and by regulating quarrying, grading, excavating or filling of land in San Francisco. Provisions of this Code shall supplement all laws of the State and the City and County of San Francisco relating to buildings and property.

Sec. 103. Scope. The provisions of this Code shall apply to the construction, alteration, moving, demolition, repair, and use of any building or structure within San Francisco.

Additions, alterations, repairs, and changes of use or occupancy in all buildings and structures shall comply with the provisions for new buildings and structures except as otherwise provided in Sections 104.A through 104.H, and 502 of this Code.

Detailed requirements for installations administered under the San Francisco Electrical Code, the San Francisco Plumbing Code, and the San Francisco Fire Code are not included in this Code.

Where in any specific case, different sections of this Code specify different materials, methods of construction, or other requirements, the most restrictive shall govern. In the case of any conflict between a general provision and a special provision of this Code, the special provision shall govern.

Sec. 104.A. Application to Existing Buildings, General. Buildings or structures to which additions, alterations, or repairs are made, or in which the occupancy of all or a portion of the building is to change from that for which a permit has been issued, shall comply with all requirements for new buildings or structures except as specifically provided in Sections 104.A through 104.H and as required in the Housing Code.

→ The term "portion of the building" shall mean the floor or floors that are affected by the change in use.

Notarized certifications describing the extent of all previous substantial alteration work and/or previous changes of occupancy shall be submitted by the owner and the designer of a proposed alteration or change of occupancy when required by the Superintendent. ←

For construction in Fire Zones, see Article 16.

Sec. 104.B. Alteration Work, Structural. In any alteration, repair, installation, or change or reconstruction of any building, the new work and any part of the building which becomes an integral part of, or is directly affected by such work, shall meet the structural requirements of this Code, →for vertical loads.

For the purpose of this section, a floor of a building shall include all the structure supporting a level of the building between the underside of said structure and the underside of the structure supporting the level of the building next above.

The extent of an existing building that is considered as being directly affected by the new work, with regard to structural considerations, shall be determined using the following criteria:

1. When structural alteration work is to be done on a floor or floors of a building or structure, the work on the floor or floors involved shall comply with the structural requirements of this Code. The structure above and below the floor or floors involved shall be improved, if and as required, so that they are not adversely affected by the structural work proposed.

2. When the floor loading is increased on the floor or floors of a building or structure, the floor or floors involved shall meet the structural requirements of this code and all structure below the floor or floors with increased loading shall not be adversely affected.

3. When more than 30%, cumulative since the building was built, of the above grade area of the building or structure are involved in substantial structural alteration work, the entire building or structure shall comply with the structural requirements of Section 104.F. ←

Sec. 104.C. Alteration Work, Architectural. In any alteration, repair, installation, or change in or reconstruction of any building, the new work and any part of the building which becomes an integral part of, or is directly affected by the new work, shall meet the requirements of this Code.

The extent of an existing building that is considered as being directly affected by the new architectural alteration work shall be determined, using the following criteria in addition to the provisions of Section 502.1:

1. All new work added to the building that did not previously exist in the building.

2. All portions of the building that are removed and replaced by new construction.

3. When 75% of the existing interior walls or partitions, as measured by the lineal footage of such interior wall and partition, are removed on a floor or when new interior walls or partitions are added which exceed 75% of the total lineal footage of the combined existing and new interior walls and partitions that would then be in place on a floor, all interior walls and partitions on the floor involved shall comply with this Code.

→ 4. Whenever alteration work involves extensive changes to elements such as walls, partitions, ceilings, etc. in substantially all portions of the structure, the structure as a whole shall comply with Section 104.F. ←

→ **Sec. 104.D. Additions to Buildings. 1. Vertical Extensions.** Buildings may be extended vertically subject to the following requirements:

a. Building shall be used for the same occupancy classification as originally built or for less hazardous occupancy classification as determined from Table No. 5-1. The occupancy of the vertical extension shall comply with the requirements of this Code.

b. Way of departure facilities for the entire structure shall be of sufficient width for the total occupancy load of the building, including the vertical extension, and shall be computed on the basis of occupant loads as assigned in the code in effect at time of the original building erection.

c. All new construction work involved in the vertical extension shall conform to the requirements of this code.

d. The structure as a whole shall comply with Section 104.F.

e. All stairways in the building serving 3 or more stories shall be enclosed.

f. For height and area limitations see Article 5.

g. The original building and the vertical extension shall comply with the applicable provisions of Article 38.

2. Horizontal Extensions

a. Building may be used for higher life safety exposure, provided the structure as a whole meets the requirements in this code for such occupancy.

b. See Subsection 1 (b).

c. See Subsection 1 (c).

d. When the cumulative area of additions above grade exceeds 30% of the above grade area of the original building and the additions are structurally interconnected to or inadequately separated from the original bujlding, the entire structure shall comply with Section 104.F.

e. See Subsection 1 (e)

f. See Subsection 1 (f)

g. See Subsection 1 (g) ←

→**Sec. 104.E. Change of Occupancy.** The exit requirements shall pertain solely to the corridors and vertical enclosures of the floor or floors affected by the change in use, which requirements shall also include the vertical enclosure for the floor next above the affected floor or floors. This exit requirement shall not include the corridors and vertical enclosures for the floors below the affected floor or floors or the corridors above the affected floor or floors, except as otherwise stated herein.

1. Where a change in occupancy classification is proposed, the requirements of Table No. 5-1 shall apply.

2. When the change in use involves an increase in the occupant load of the floor or floors affected or when the change involves Occupancies A, B, C, D and E, the exit requirements shall include the vertical enclosures in accordance with Article 33 from the floor or floors in question to the ground at a street or public space. The exit requirements shall include the corridors of the floor or floors affected by the change in use and shall not include the corridors for the floors above or below the affected floor or floors.

3. Whenever the cumulative areas involved in change of occupancy to a greater life safety exposure from that for which the building was originally designed exceed 30% of the original above grade area of the building, the entire building shall be made to comply with Section 104.F.

EXCEPTIONS: 1. When the occupancy change is to a Group A, B Div. 1 or B Div. 2 classification and Group B Div. 3 classification with an occupant load over 300, the entire building shall be made to comply with Section 104.F.

2. When the occupancy change is to a Group C classification the entire building shall be made to comply with the requirements of footnote 1 of Table No. 5.1 as well as with Sec. 104.F. ←

→**Sec. 104.F. Lateral Force Design Requirements.** The provisions of Sec. 2308 and Sec. 2314.D through .H shall apply to the entire building or structure. It shall be demonstrated that the entire building or structure is capable of resisting these forces and safeguarding the occupants and the public.

Consideration shall be given to all aspects of construction which may affect safety; including but not necessarily limited to the adequacy of connections between structural members, the adequacy of building separation and the security of unreinforced filler walls as well as parapets and appendages.←

→**Sec. 104.G. Existing Occupancy.** Buildings in existence at the time of the passage of this Code may have their existing use or occupancy continued, if such use or occupancy was legal at the time of the passage of the Code, provided the building construction met the requirements in effect at the time of construction and alteration and such continued use is not dangerous to life or is substandard under the Housing Code.

Any change in the use or occupancy of any existing building or structure shall comply with the provisions of Sections 306 and 502. No change in the percentage of lot occupied shall be permitted, whether by sale, conveyance or otherwise, so as to diminish the required size of yards, courts or passageways.←

→**Sec. 104.H. Maintenance.** All buildings or structures both existing and new, and all parts thereof, shall be maintained in a safe and sanitary condition. All devices or safeguards which were previously required and which are required by this Code in a building or structure when erected, altered, or repaired, shall be maintained in good repair. The owner or his designated agent shall be responsible for the maintenance of buildings and structures. ←

Sec. 105. Moved Buildings. Buildings or structures moved into or within the City shall comply with the provisions of this Code for new buildings or structures. See Article 16 for requirements in the Fire Zones.

Sec. 106. Alternate Materials and Methods of Construction. It is the declared intention of this Code to define minimum standards of construction which shall produce safe structures. No provisions of this Code are intended to prevent the use of any material, appliance, installation, device, arrangement, or method of construction not specifically prescribed herein, provided such alternate has been approved.

The Superintendent may approve any such alternate if he finds that the proposed designed satisfies structural and other Code requirements and that the material, appliance, installation, device, arrangement, method of work offered is, for the purpose intended, obviously equivalent or better in quality, strength, effectiveness, fire resistance, durability, safety, and for the protection of life and health, than that called for by provisions of this Code.

The Superintendent may require that sufficient technical data be furnished to substantiate any claims made by the applicant in regard to the use of any such alternate.

→ Sec. 106.1. Fees and Term of General Approval and Renewal Materials or Methods of Construction. Applications for the issuance and renewal, by the Superintendent, of general approvals of materials and methods of construction shall be accompanied by the proper fee as stated herein:

General Approval - initial or reistatement - $20
General Approval - modification or revision - $5
General Approval - renewal (every 2 years) - $10

The fees specified are application fees and are not refundable, regardless of whether the action taken is an approval or a denial or whether a subsequent request for hearing by the Board of Examiners is filed.

Each approval shall become null and void 90 days after a request for confirmation of renewal has been sent and said confirmation together with the applicable renewal fee has not been received by the Superintendent. ←

→ Sec. 106.1.A. Building Inspection Revolving Fund. All fees paid for issuance or renewal of approvals shall be deposited into a special Building Inspection Revolving Fund to be established by the City Controller. Funds from this revolving fund, subject to the approval of the Director and the Chief Administrative Officer, shall be utilized to provide information to the construction industry of said approvals and methods of construction and related services to the construction industry.

Any fees established by the Director for copies of approvals or publications summarizing said approvals shall also be allocated to said Building Inspection Revolving Fund to provide funds for said activities. Said Revolving Fund shall continue from year to year and shall not be included in the Cash Reserve Fund. ←

→ Sec. 106.1.B. Validity of General Approvals. Any general approval shall be void if, after approval, the device, material or method of construction is found to deviate in any way from the approved device, material or method of construction, without having first obtained written authorization from the Superintendent.

Any approval may be suspended or revoked by the Superintendent if he finds the approved device, material or method of construction does not meet the requirement of Section 106 to such an extent that the approval should not have been granted. ←

Sec. 107. Tests. Whenever there is insufficient evidence of compliance with the provisions of this Code or evidence that any material or any construction does not conform to the requirements of this Code, or in order to substantiate claims for alternate materials or methods of construction, the Superintendent may require tests as proof of compliance to be made at the expense of the owner or his agent by an approved agency.

Sampling, preparation of samples and tests shall be in accordance with the applicable standards of the American Society for Testing and Materials; unless otherwise provided in the approved specifications, by the Superintendent or in this Code.

Sec. 108. Plans Being Prepared at Time of Passage of This Ordinance to the Building Code. Nothing herein shall prevent the completion of plans and the construction of a building for which a designer, architect, civil or structural engineer, → or the design engineer for specialty areas of this Code such as heating and ventilation ← holds a contract for preparation of plans and specifications, which plans are substantially completed at the time of the passage of this Ordinance, provided such plans and specifications would have conformed to the Code in effect prior to this Ordinance. Notification of such situations addressed to the Superintendent must, however, be filed in writing within 30 days after the enactment of this Ordinancccce. The notification shall be accompanied by one set of plans indicating that the drawings, both architectural and structural, are at least 50% complete.

The decision of the Superintendent as to the sufficiency and status of plans under this section shall be final. This section shall not apply to 1 or 2 story frame residences.

118 ARTICLE 5 Table No. 5.1.

TABLE NO. 5.1

OCCUPANCY CHANGES PERMISSIBLE WITHOUT CONFORMING TO ALL PROVISIONS OF PRESENT CODE

To / From	OCCUPANCY GROUP																												
	A	B-1	B-2	B-3	C[1]	D-1	D-2	D-3	E-1	E-2	E-3	E-4	F-1[2]	F-2	F-3	G	H	I	J-1
A	P	P	P	P	P		P5	P5					P5	P	P5			P5	P
B-1	P5	P	P5	P	P		P5	P5					P5	P	P5			P5	P
B-2	P5	P5	P		P		P5	P5					P5	P				P5	P
B-3				P	P		P5	P5					P5	P				P5	P
C				P5	P	P5	P5	P5					P5	P			P5	P5	P
D-1				P5		P							P5	P			P5	P5	P
D-2				P5	P		P	P					P5	P			P5	P5	P
D-3				P5	P			P					P5	P			P5	P5	P
E-1									P	P	P		P5	P			P5	P5	P
E-2									P5	P	P	P	P5	P			P5	P5	P
E-3									P	P5	P		P5	P			P5	P5	P
E-4												P	P5	P			P5	P5	P
F-1													P	P			P5	P5	P
F-2				P5	P5			P5					P5	P			P5	P5	P
F-3															P	P5			P
G				P5		P5	P5	P5				P5		P		P	P5		P
H				P5	P5			P5						P			P	P5	P
I																		P	P
J-1																			P

LEGEND for Table No. 5.1

P — Occupancy change permitted subject to the requirements of Sections 302.1 and 1706.A, except for ducts, Tables No. 5-C, 5-D, and 5-E, and Article 38.

P5 — Occupancy change permitted subject to requirements as set forth by the Superintendent, and the Bureau of Fire Prevention and Public Safety for those occupancies under their jurisdiction.

Where square is blank, change in occupancy requires substantial conformance with all present code provisions.

[1] Shall require conformance with Article 23 for seismic provisions. Same as used by State OAC. [2] Not including service stations and gasoline filling stations.

Sec. 204.2 Director may adopt Rules and Regulations. The Director of Public Works may adopt and promulgate rules and regulation supplemental to this Code and not in conflict with the intent therewith. → Such rules and regulations shall be generally accepted or approved methods and practices for the public health and welfare and safety of life, subject to re-examination and change if at any time such rules and regulations are found to be not in conformance with the intent or requirements of the Municipal Code.

The Director may administratively authorize the processing of applications involving Housing Code compliance actions initiated by the Department of Public Works, in a manner other than set forth in this Code, so as to effect said compliance most expeditiously; provided however that due process is assured all applicants. In this regard, the Director may reduce the time periods set forth in Sections 301.C.3, 302.D and 302.D.2 as they apply to a second application required by the Director to effect full compliance with the Housing Code if by so doing compliance with the Housing Code would be more expeditiously accomplished.

State of Massachusetts

STATE OF MASSACHUSETTS

Code Provisions

Prior to June 1, 1979, Massachusetts had a mandatory State building code based upon the BOCA Basic Building Code which incorporated the 25-50% Rule. On June 1, 1979, a new section of the State code became effective. It is labeled Article 22, and is entitled "Repair, Alteration, Addition and Change of Use of Existing Buildings," replacing the 25-50% Rule and the change of occupancy regulation. A copy of Article 22 and Appendix T, Reference Data, are reproduced below.

Article 22 is based on the Rehabilitation philosophy that anything can be done to an existing building that increases or does not reduce the performance of the building as it exists with the provision that certain minimum standards must be met with regard to structural adequacy, and number and capacity of exits.

Article 22 discards completely any reliance on the value of the building or the work to be done. Instead, the requirements are based on ranking the various occupancy classifications in order of increasing hazard. Briefly, three levels of compliance are specified as a function of the hazard classification:

- If a building is rehabilitated (altered or repaired) with no change in use or with a change in use to an equal or lower hazard, regardless of the amount of work to be performed, if the work does not adversely affect the performance of the building, it may be accomplished with materials equivalent to those already in place. New systems should conform to the code for new construction "to the fullest extent practical," while encouraging the acceptance of equivalent alternatives. With a change in use to an equal or lower hazard, specific requirements for exit lighting, signs, alarms, and a smoke-proof but unrated stair enclosure must be complied with.

- If the use is to be changed a single step in the more hazardous direction, the entire building must meet the requirements of the code for new construction, with eight specified exceptions in the fire safety and structural areas. Equivalent compliance alternatives are encourgaged.

- If the use is changed two or more steps in the more hazardous direction, the building must be made to comply in all respects with the code requirements for new construction but still explicitly encouraging equivalent compliance alternatives.

Ordinary repairs (as defined in the Massachusetts code) are exempted from Article 22.

Operation of the Code

A set of guidelines (Appendix T) has been published to aid building departments and applicants in the use of Article 22.

The single number hazard index for ranking occupancies, as adopted in Article 22, has been criticized by some building officials and by the model code groups. It is stated that the rankings do not account for all hazards and risks, and could lead to increased hazard without rising on the hazard index.

Article 22 is an extremely interesting and innovative approach to the problem of regulating existing buildings. Since it has only been in use a short period of time, no definitive conclusions can yet be drawn on the effectiveness of this approach.

Article 22

REPAIR, ALTERATION, ADDITION, AND CHANGE OF USE OF EXISTING BUILDINGS

SECTION 2200.0 SCOPE

2200.1 General: The intent of these provisions is to provide for the public safety, health and general welfare by permitting repair or alteration of, additions to, and change of use of, existing buildings and structures or parts thereof without requiring the existing building or structure to comply with all of the requirements of this code for new construction except where otherwise specified in this article. This article is not intended to prevent conformance with the requirements of this code for new construction.

Note: Specialized codes, rules, regulations and laws pertaining to repair, alteration, addition or change of use of existing structures promulgated by the various authorized agencies may impact upon the provisions of this article. Specialized state codes, rules, regulations, and laws include, but are not limited to, those listed in Appendix P.

SECTION 2201.0 DEFINITIONS

2201.1 General: Definitions shall be construed as being the same as defined in Article 2 except as follows.

Building system: Any mechanical, electrical, structural, egress, or fire protection system.

Existing building or structure: Any completed building or structure.

Hazard index: The rating of a use group for relative hazard as listed in Table 2203.

SECTION 2202.0 APPLICATION

2202.1 General: Where there are not specific provisions in this article applying to the repair, alteration of, additions to, and changes of use of any existing building or structure or part thereof, then such building or part thereof shall be made to comply with the pertinent provisions of this code for new buildings or structures. The provisions of this article shall apply to existing buildings and structures which have been occupied and/or used for a period of at least two (2) years.

For any proposed work covered by this article, the building owner shall cause the existing structure to be investigated and evaluated. The investigation shall provide sufficient information to satisfactorily determine the performance level of the existing structure with the proposed work incorporated.

2202.2 Repair or alteration: The repair or alteration of existing buildings and structures shall comply with the requirements of this article, except for ordinary repairs as provided for in Section 102.0.

2202.3 Additions to existing buildings: Additions to existing buildings and structures shall comply with the requirements of Section 2203.4.

2202.4 Change in existing use

2202.4.1 Continuation of existing use: The legal use and occupancy of any building or structure may be continued without change, except as may be specifically covered in Sections 405.1 and 405.2 of this code, or as may be deemed necessary by the building official for the general safety and welfare of the occupants and the public.

2202.4.2 Change in use: A change shall not be made in the use group of any building which would place the building in a different use group unless such building is made to comply with the requirements of this article.

2202.4.3 Part change in use: If a portion of the building is changed to a new use group, and that portion is separated from the remainder of the building with the required vertical and horizontal fire separation assemblies complying with the fire grading in Table 902, or with approved compliance alternatives, then the portion changed shall be made to conform to the requirements of this article.

If a portion of the building is changed to a new use group, and that portion is not separated from the remainder of the building with the required vertical and horizontal fire separation assemblies complying with the fire grading in Table 902 or with approved compliance alternatives, then the provisions of this article applying to each use shall apply to the entire building; and if there are conflicting provisions, the requirements securing the greater public safety shall apply.

2202.5 Historic buildings: Historic buildings shall meet the applicable provisions of Article 4 of this code.

2202.6 Reference standards: The building official may use Appendix T when determining compliance with this article.

2202.7 Permit application: In addition to the requirements specified in Article 1, the application for a building permit shall include items of non or partial compliance with the requirements of this article, and compliance alternatives, if any are proposed, for approval by the building official. The building official shall respond to the acceptability of any proposed compliance alternatives within thirty (30) days of the filing of the building permit application.

2202.8 Documentation: Whenever action is taken on any building permit application to repair, make alterations, or change the use or occupancy of an existing structure, and when said application proposes the use of compliance alternatives, the building official shall insure that one (1) copy of the proposed compliance alternatives, including applicable plans, test data or other data required for evaluation, be submitted to the Commission, along with a copy of the building permit application and the building official's decision regarding the proposed compliance alternatives.

SECTION 2203.0 REQUIREMENTS

2203.1 Buildings exceeding code requirements for new construction: Existing buildings and structures which, in part or as a whole, exceed the requirements of this code, may, in the course of compliance with this article, reduce or remove in part or total, features not required by this code for new construction, provided, however, that such features were not a condition of prior approval.

2203.2 Buildings not meeting code requirements for new construction: Provided their present degree of compliance to the code is not reduced, existing buildings and structures which, in part or as a whole, do not meet the requirements of this code for new construction may be altered or repaired without further compliance to the code by utilizing the provisions of this article.

2203.3 Compliance alternatives: Where compliance with the provisions of this code for new construction, required by this article, is impractical because of construction difficulties, acceptable compliance alternatives may be used. Appendix T contains some acceptable compliance alternatives. The building official may accept compliance alternatives other than those listed in Appendix T.

2203.3.1 File: In accordance with Section 2202.8, the building official shall provide the Commission with information regarding compliance alternatives accepted or rejected by him. It is the intent of the Commission to amend those acceptable compliance alternatives listed in Appendix T.

2203.4 Additions: Additions to an existing building shall comply with all code requirements for new construction. The combined height and area of the existing building and new addition shall not exceed that permitted by this code for new construction. Where a fire wall complying with Section 907.0 is provided, the addition may be considered as a separate building. However, the existing building shall comply with Sections 2203.1 and 2203.2.

The addition shall not impose loads either vertical or horizontal which would cause the existing building to be subjected to stresses exceeding those permitted by this code for new construction.

2203.5 Increase in floor load: Any proposed increase in floor loading shall be investigated to determine the adequacy of the existing floor system to support the increased loads. If the existing floor system is found to be inadequate, it shall be modified to support the increased loads or the proposed allowable floor loading shall be reduced and posted.

2203.6 Hazardous conditions: The conditions or defects described in Sections 2203.6.1 through 2203.6.3 below shall be deemed to be hazardous and shall be corrected. This section shall not be construed to limit the authority of the building official under Section 123.0.

2203.6.1 Structural: Any building or structure or portion thereof which is in imminent danger of collapse because of, but not limited, to the following factors:

1. dilapidation, deterioration, or decay;
2. faulty design and/or construction;
3. the removal, movement or instability of any portion of the ground necessary for the purpose of supporting such building; and
4. the deterioration, decay or inadequacy of the foundation.

2203.6.2 Number of exits: Less than two (2) approved independent exitways serving every story, except in one- and two-family dwellings and as modified in Sections 417.0 and 418.0 and 609.3.

2203.6.3 Capacity of exits: Any required door, aisle, passageway, stairway or other required means of egress which is not of sufficient width to comply with Section 606 and is not so arranged as to provide safe and adequate means of egress.

2203.7 No change in use

2203.7.1 Minor alterations and repairs: Alterations or repairs which do not adversely affect the performance of the building may be made with the same or like materials.

2203.7.2 New systems: When the proposed alteration does not involve a change in use group then further compliance with the requirements of the code for new construction is not required, except that any

new building systems shall conform to the code for new construction to the fullest extent physically practical in accordance with Section 2203.3 of this article.

2203.7.3 Increase in occupancy load: If an increase of greater than fifteen (15) per cent in the occupancy load is involved, the building shall comply with this code for new construction with regard to egress requirements. Existing exitway facilities may be used in contributing to the total calculated egress requirements.

2203.7.4 Increase in number of dwelling units: If the number of dwelling units in buildings of use group R (residential) is increased, the building shall comply with Sections 2203.8.1.1 through 2203.8.1.5 inclusive.

2203.7.5 Places of assembly: Provisions herein contained shall not prohibit the alteration of a building heretofore occupied as a place of public assembly for such continued use provided the seats, aisles, passageways, balconies, stages, appurtenant rooms and all special permanent equipment comply with the requirements of Sections 417.0 and 418.0.

2203.8 Change in use group: Any change in use to use group I (Institutional) shall comply with the requirements of this code for new construction. For all other changes in use, the building official shall first determine whether the alteration results in a lesser, equal, or greater hazard in accordance with Table 2203. Change in use group shall be evaluated relative to the last known legal occupancy of the building.

2203.8.1 Equal or lesser hazard: When the proposed use is of equal or lesser hazard, further compliance with the code for new construction is not required except as specified herein. Alterations or repairs to an existing building or structure which do not adversely affect the performance of the building may be made with like materials. Any proposed change to the existing building or change in type of contents of the existing building shall not increase the fire hazard to adjacent buildings or structures. If the fire hazard to adjacent buildings or structures is increased, then the requirements of Table 214 for exterior walls shall apply.

2203.8.1.1 New systems: Any new building system shall conform to this code for new construction to the fullest extent practical in accordance with Section 2203.3 of this article.

2203.8.1.2 Exit signs and lights: Exit signs and lights shall be provided in accordance with Section 623.0.

2203.8.1.3 Means of egress lighting: Means of egress lighting shall be provided in accordance with Section 624.0.

2203.8.1.4 Fire alarm systems: Fire alarm systems shall be provided in accordance with Sections 1216.0 and 1217.0.

2203.8.1.5 Enclosure stairways: Open stairways shall be enclosed except as otherwise permitted by Article 6. For the purpose of this section only, there shall not be a minimum fireresistance rating for the enclosure. All doors in the enclosure shall be self-closing.

2203.8.1.6 Places of assembly: All buildings of use group A (assembly) shall comply with Sections 417.0 and 418.0.

2203.8.2 Greater hazard

2203.8.2.1 Increase in one hazard index number: When the proposed change in use results in a use group one (1) hazard index number higher than its present use group as defined in Table 2203, the entire building must meet the requirements of the code for new construction with the following exceptions.

a. Compliance is required with Sections 213.0 and Table 902 except that floors providing horizontal separation in buildings of Types 3 and 4 construction equipped with a fire suppression system shall have a fireresistance rating of not less than one (1) hour.
b. Further compliance is not required with Section 302.2.
c. Further compliance is not required with Sections 305.2 and 305.3, e.g. a change in use is allowed in an existing structure even if it exceeds the area and height limits of Table 305.
d. Further compliance is not required with Section 315.1.
e. Compliance is required with Section 616.0 except that existing exitway stairways may be used as part of the required egress for the new use, provided that the width is of sufficient capacity for the occupancy load, they are structurally sound, and that the enclosures in buildings of Types 3 and 4 construction shall have a fireresistance rating of not less than one (1) hour. Enclosures in buildings of Type 1 and 2 construction shall have a fireresistance rating of not less than two (2) hours. Where stair exitway doors are doors to an apartment or office, they need not swing onto the landing.
f. For earthquake resistance and liquefaction, further compliance to Sections 718.0 and 723.0 is not required. Structural alterations may be made to existing buildings and other structures, but the resistance to lateral forces shall not be less than that before such alterations were made, unless the building or structure as altered meets the requirements of this code for earthquake loads.
g. Further compliance is not required with Section 815.0.
h. Further compliance is not required with Sections 868.0 and 907.0. The height above the roof of existing fire, party and exterior walls need not comply with these sections.

2203.8.2.2 Increase of two or more hazard index numbers: When the proposed change in use results in a use group two (2) or more hazard index numbers higher than its present use group as defined in Table

2203, the entire building must meet the requirements of this code for new construction.

Table 2203
HAZARD INDEX

Scale: 1-8 (1 is lowest, 8 is highest hazard)

Use group*	Description	Index no.
A-1-A	Theatre with stage	6
A-1-B	Theatre without stage	5
A-2	Night club	7
A-3	Restaurant	5
	Lecture halls, recreation centers, museums, libraries, similar assembly buildings	4
A-4	Churches and schools	4
B	Business	2
F	Factory and industrial	3
H	High hazard	8
I-1	Institutional restrained	5
I-2	Institutional incapacitated	4
M	Mercantile	3
R-1	Hotels, motels	2
R-2	Multi-family	2
R-3	1 and 2 family	2
S-1	Storage, moderate hazard	3
S-2	Storage, low hazard	1

*See Sections 203.0 thru 212.0 and Appendix T.

SECTION 2204.0 OTHER CODE SECTIONS PERTAINING TO EXISTING STRUCTURES

2204.1 General: The following is a list of some additional code sections which may pertain to repair, alteration, addition, or change of use of existing structures.

101.1	Applicability
102.0	Ordinary repairs
103.0	Installation of service equipment
104.0	Maintenance
105.0	Change in existing use
106.0	Alterations and repairs
108.5.1	Duties and powers of the building official and state inspector, inspection and certification, specified use groups
111.1	Preliminary inspection
111.5	Inspection, existing buildings
116.0	Demolition of structures
117.0	Moved structures
119.2	Certificate of use and occupancy, buildings or structures hereafter altered
120.0	Posting structures

121.0	Violations
123.0	Unsafe structures
124.0	Emergency measures
302.0	Restrictions within the fire limits
309.0	Street encroachments
403.0	Fire prevention code
405.0	Existing buildings
417.2.2	Places of public assembly, superimposed theatres
417.2.3	Places of public assembly, frame construction
424.2	Group residence, existing buildings
435.2	Summer camps for children, new and existing occupancies
436.0	Historic buildings
505.0	Existing buildings (light, ventilation and sound transmission control)
600.1	Means of egress, scope
600.2	Modification of exitway requirements
605.0	Maintenance of exitways
621.0	Fire escapes
705.0	Structural and foundation loads and stresses, existing buildings
716.6.7	Earthquake loads, minor alterations
804.4	Heretofore approved materials
924.6	Exterior trim restrictions, existing combustible construction
926.2	Roof coverings, existing roofs
1005.0	Chimneys, flues, and vent pipes, existing buildings
1103.0	Mechanical equipment and systems, existing buildings
1200.3	Fire protection systems, maintenance
1200.8	Fire protection systems, periodic inspections and tests
1201.1	Fire protection systems, plans and specifications required
1201.2	Fire protection systems, plans and specifications approved by other agencies
1212.7	Standpipes for buildings under demolition
Article 13	Precautions during building operations
1403.0	Unsafe and unlawful signs, notices
1404.0	Existing signs
1405.0	Signs, maintenance and inspection
2001.3	Energy conservation, existing buildings
2001.4	Energy conservation, exempt buildings
2002.0	Energy conservation, existing buildings
2015.0	Lighting power limits for existing buildings
2100.2.4	Building code provisions for one and two-family dwellings, alterations to existing buildings

APPENDIX T

REFERENCE DATA FOR REPAIR, ALTERATION, ADDITION AND CHANGE OF USE OF EXISTING BUILDINGS

PART ONE—GUIDELINES FOR APPLICATION

T-101.0 Purpose

T-101.1 Intent of Article 22: The purpose of this guideline is to provide guidance to users of the Massachusetts State Building Code as to techniques of acceptable practice which can be used to assess the acceptability of various methods of meeting the intent of the code provisions of Article 22 on a case-by-case basis. The purpose of the code provisions in Article 22 and this guideline is to allow repair, alteration, addition and change of use of existing buildings without requiring the entire building to be brought up to new construction requirements, while still providing for the public health, safety and general welfare. The provisions of Article 22 and this guideline recognize that the provisions of the Massachusetts State Building Code for new construction reflect the latest improvements in materials, construction techniques, standards of living and safety and therefore may preclude the repair, alteration, addition, or change of use of existing buildings that have demonstrated their usefulness and safety.

T-102.0 Scope

T-102.1 Techniques: This guideline is intended to demonstrate techniques of analysis and compliance with Article 22 of the Massachusetts State Building Code in the repair, alteration, addition, and change of use of existing buildings.

T-103.0 Statement of concept

T-103.1 General Conditions: Conceptually, it is the intent of Article 22 and these guidelines to allow repair, alteration, addition, or change of use of existing buildings without meeting all new construction requirements under the following general conditions:

1. all hazardous conditions must be corrected;
2. the existing building becomes the minimum performance standard; and
3. the degree of compliance of the building after changes must not be below that existing before the changes, except that nothing in this section will require compliance with requirements more stringent than that required for new construction.

T-104.0 Implementation

T-104.1 Framework: Implementation of the above concept requires that a framework be established for evaluating the condition of the building; determining the potential for modification; and establishing the acceptability of proposed changes.

T-104.2 Evaluation of existing building: Evaluation of existing conditions in a structure is required to determine the existence of any hazardous conditions, which must be corrected; and to provide a basis for evaluating the impact of the proposed changes on the performance of the building.

The following list of evaluation tools described in Sections T-104.2.1 through T104.2.7 of this appendix can be used for determining the condition of the structure. However, this list is not necessarily complete and the use of other methods should not be precluded.

T-104.2.1 Available documentation of existing building: Prime sources of design information for existing buildings are the architectural and engineering drawings and specifications used in the construction of the building. Although the passing of time often obscures the identities of depositaries of such documents, the following are likely prospects in attempting to locate such information.

1. If the building is currently in use, an individual or office responsible for its management may have retained drawings and specifications to facilitate maintenance. A building manager, resident engineer, superintendent, custodian, stationary engineer or plant engineer may be the most direct contact at the building site.
2. Other potential sources (especially if the building is not in use) include the original designer-architect or engineer.
3. The building department which issued the permit for construction may have documentation.
4. Documentation may have been retained by the general contractor or numerous subcontractors. This presents the possibilities of the mason, carpenter, plumber, electrician, HVAC installer, steel erector, etc., as well as manufacturers of component parts.
5. In the case of large corporations or government agencies, a separate contracting officer may have developed a technical file on the erection of a building.
6. In some cases, individual consultants are contracted to serve as "clerk-of-the-works" and pursue the inspection of a building project from start to finish with the keeping of a file likely.
7. Insurance companies sometimes maintain drawings or records of their insured buildings.
8. Historical or archaeological societies may have considered a building to be important enough to develop a file of documentation.

T-104.2.2 Field surveys: Having drawn upon available documentation to help evaluate a building's condition, such documentation may be augmented by on-site data acquired through field survey. The most obvious approach is to make use of detailed visual examination to confirm and/or alter any previously available information pertaining to the building.

T-104.2.3 Testing: Testing is a tool that may be used in evaluating the condition of a building or structure or parts thereof when other methods of evaluation will not suffice. Testing may be initiated voluntarily on the part of the permit applicant or may be required by the building official in the absence of approved rules as indicated in Section 800.6 of the code. This section points out that ". . . the building official shall make or cause to be made the necessary tests and investigations, or he shall accept duly authenticated reports from recognized authoritative sources." The costs of all such tests are to be borne by

the permit applicant and should therefore be required by the building official *only when other methods of evaluation prove inadequate or insufficient*. Such testing should be conducted by an approved testing agency under the supervision of a registered architect or engineer. The report of the tests shall be submitted to the building official and shall include the details of test procedures, references to any accepted test standards used, the results of the tests and any conclusions drawn from the test results.

T-104.2.4 Field tests: Both non-destructive and destructive test procedures can be applied to evaluate the condition of a building.

T-104.2.5 Non-destructive testing: This includes techniques where the structural integrity of the building is not affected, such as the following:

1. analyzing various portions of the building to determine dimensions, types and condition of materials, etc.;
2. portable apparatus for impact testing;
3. load application short of failure to determine capacity of materials and components;
4. magnetic methods for detecting flaws in ferrous metals;
5. proximity magnetometers (locating rebars in concrete, concealed ferrous fasteners, etc.);
6. electronic means for measuring the sonic modulus of elasticity of concrete and masonry in assessing its soundness;
7. ultrasonic transmission or reflective methods in detecting flaws in various materials; and
8. x-ray or infrared-ray photographic techniques used to evaluate portions of elements whose integrity is questionable.

T-104.2.6 Destructive testing: In destructive testing a sample of the building could be removed and tested (e.g., concrete core), or components of the building could be reconstructed and tested in the laboratory.

T-104.2.7 Laboratory analysis: In some cases, tests can be performed in the laboratory. Such tests might include the following:

1. chemical or metallurgical tests;
2. optical or electronic microscopic examination which can help identify and evaluate the soundness of materials where decay or other molecular degradation is involved;
3. conventional laboratory tests for determining physical properties (strength, ductility, absorption, solubility, permeability, strength, stiffness, etc.); and/or
4. testing of a scale model of the building (computer model, wind tunnel model, etc.).

T-104.3 Evaluation of change in performance level: It is necessary to determine if the level of performance of the building after alteration is below that which existed before the change. The hazard level could be increased for certain attributes (such as fire safety) while decreased for other attributes (such as floor loads) for a given alteration. The evaluation of the change in hazard levels of each attribute can be accomplished using various tools singly or in combination as described below in Sections 104.3.1 through 104.3.5.

T-104.3.1 Data on archaic systems: Performance data on architectural and structural systems being encountered in existing buildings in the Commonwealth are tabulated in part four of this appendix. This data can be compared to the proposed altered systems to determine if the performance is being adversely affected.

T-104.3.2 Compliance alternatives: Alternate solutions tabulated in part two of this appendix were developed from appeal data and from accepted practice. The list is not all-inclusive and should not preclude consideration of other alternatives.

T-104.3.3 Analysis methods: Analytical methods based on good engineering practice may be used to determine changes in performance levels.

T-104.3.4 Test methods: Test procedures as discussed in Sections T-104.2.3 through T-104.2.6 of this appendix can be used to evaluate the performance of existing construction.

T-104.3.5 Professional judgment: Professional judgment based on previous experience with similar buildings should be used to the fullest extent possible.

PART TWO—SUGGESTED COMPLIANCE ALTERNATIVES

T-201.0 Purpose and scope

T-201.1 Purpose: The purpose of this reference is to assist the building official and those regulated by this code in judging the acceptability of compliance alternatives to specific code provisions required by the code.

T-201.2 Application: This reference contains generally acceptable compliance alternatives and examples. The examples are solely for the purpose of illustrating principles which can be applied to the solution of code compliance problems and are not necessarily acceptable under all circumstances. It is recognized that all building systems interact with each other. Therefore, any consideration of compliance alternatives must take into account all existing and proposed conditions to determine their acceptability. The principles applied can be used for the solution of similar compliance problems in other buildings and occupancy groups. Commentaries are provided where the philosophy in establishing the alternatives is not obvious. The examples were developed from appeal data and accepted practice. They are not all-inclusive and should not preclude consideration of other alternatives.

Note: It is anticipated that additional compliance alternatives will be added to this reference through the mechanism of appeal decisions and from results of research being conducted by various organizations in the field of relative performance of life safety systems.

T-202.0 Compliance alternatives for egress requirements

T-202.1 Number of exits

T-202.1.1 General compliance alternatives

1. Provide connecting fire balconies.
2. Provide alternate egress facilities (windows, etc.).

3. Provide a fire escape.
4. Provide fire rated areas of refuge.

T-202.1.2 Examples: Example 1 involves a five-story "row house" of occupancy group B without a fire suppression system and with only one means of egress.

Solution A. Add one or more fire escapes as may be necessary to provide all tenants with reasonable access to two means of egress in separate directions. Access to a street, public way or area of refuge shall be provided at the termination of the fire escape.

Solution B. Add connecting fire balconies across fire walls if the above solution is impractical due to construction difficulties.

Example 2 involves a building of group R-2 occupancy with an apartment in the basement. There is only one means of egress from the basement.

Solution A. Provide egress windows in each apartment that comply with Section 609.4.

T-202.2 Travel distance

T-202.2.1 General compliance alternatives

1. Add detection system.
2. Add a partial fire suppression system.
3. Add smoke doors.
4. Increase fireresistance rating of corridor walls and doors.

T-202.2.2 Examples: This example involves a four-story building of occupancy group R-2 without a fire suppression system. The length of exitway access travel is 150 feet.

Solution A. Add a partial fire suppression system off the domestic water supply (if adequate) in the exit access corridor.

Solution B. Subdivide corridor into segments less than 100 feet with smoke doors.

Solution C. If not required by other sections of the code, install smoke and fire detectors with audible alarms in the corridor.

Solution D. Increase the fireresistance rating of the exit access corridor from one hour to two hours and provide 1½ hour "B" label self-closing or automatic closing fire doors in all openings into the corridor.

T-202.3 Enclosure of exitways

T-202.3.1 General compliance alternatives

1. Improve enclosure of exitway.
2. Add a partial fire suppression system.
3. Add a detection system.

T-202.3.2 Examples: This example involves a four-story row building of occupancy group R-2 with connecting fire balconies and an interior stair. The stair is enclosed with wood lath and plaster on wood stud partitions and paneled doors.

Solution A. Cover partitions on the apartment side with ⅝" Type X gypsum wallboard or its equivalent. Replace or build up panel doors until minimum solid portion is 1⅜" and install self-closers.

Solution B. Provide a heat and smoke detection system in the stairwell with an alarm audible to all tenants. Provide self-closers on all stairwell doors.

Solution C. Provide a partial fire suppression system in the stairwell off the domestic water supply (if adequate). Provide self-closers on all stairwell doors.

T-202.3.3 Commentary: The above example, while pertaining to a four-story group R-2 building, can also be applied to other buildings of various height and occupancies. The principle that the degree of compliance may not be reduced should be remembered. If the existing enclosure is of fireresistive construction, it must be maintained. The primary principle to remember, in the required enclosure of exitway, is that an enclosure must be provided, whether fireresistive or not, so as to provide a smoke barrier. The purpose of providing a smoke barrier is to prevent the passage of smoke from a fire on one floor to the exitways and exit access corridors of other floors and thus rendering them unusuable for egress. This principle is illustrated by solutions A, B, and C in the above example.

T-203.0 Compliance alternatives for fire hazards

T-203.1 Fire separations and partitions

T-203.1.1 General compliance alternatives

1. Improve fire separation.
2. Add a fire suppression system.
3. Add a detection system.

T-203.1.2 Examples: Example 1 involves a three-story, Type 3A building, of occupancy group M on the first floor and occupancy group B on the second and third floors. The required separation is three hours.

Solution A. Add a fire suppression system to the first and second floors.

Solution B. Add ⅝" Type X gypsum wallboard or its equivalent to the underside of the second floor and install a system of smoke and heat detectors with audible alarms on the first and second floors.

Example 2 involves the separation between two tenants of wood lath and plaster on a wood studs partition. The required separation is one hour.

Solution A. Add ⅝" Type X gypsum wallboard or its equivalent to either side of the existing partition.

Example 3 involves a building of occupancy B with unrated exit access corridors.

Solution A. Install a partial fire suppression system in the exit access corridors.

Solution B. Add ⅝" Type X gypsum wallboard or its equivalent to either side of the corridor partition and install self-closers on all corridor doors.

Solution C. Install a smoke and heat detection system in the corridor with an alarm audible to all tenants on the floor and install self-closers on all corridor doors.

T203.2 Openings and exterior wall protection

T-203.2.1 General compliance alternatives

1. Add fire suppression system.
2. Improve fireresistance.
3. Remove or improve openings.

T-203.2.2 Examples: Example 1 involves a two-story Type 4B building, of occupancy M on the first floor with the basement and upper floors used for storage. The distance between the building and the side lot line is five feet and between it and the adjacent building is ten feet. The adjacent building is of Type 4B construction and of occupancy group R-2. The former occupant was a grocery store; the new occupant is a hardware store.

Solution A. Install a deluge sprinkler system along the interior side of the wall affected.

Solution B. Add ⅝" Type X gypsum wallboard to interior side of the wall affected.

Example 2 is the same as example 1 but with doublehung wood windows in affected wall.

Solution A. Remove windows and close opening with one-hour fire-resistive construction.

Solution B. Remove windows and install fire windows.

Solution C. Install a deluge sprinkler system as in solution A to example 1.

PART THREE—DETAILED CLASSIFICATION OF OCCUPANCY BY HAZARD INDEX NUMBER AND USE GROUP

This part provides a more detailed guide for users of the code to determine hazard index numbers and use groups for various types of occupancies. It supplements Article 2 and Table 2203 contained in Article 22.

Table T-1
HAZARD INDEX AND USE GROUP CLASSIFICATION

Use of structure	Hazard index number	Use group
Advertising displays manufacture including billboards	3	S-1
Airport or other aircraft landing or service facility (see also: Helicopter rooftop landing facility)	3	F
Amusement park, indoor	4	A-3
Animal		
Crematorium	3	F
Hospital, kennel, pound	2	B
Apartment (see Residences)		
Appliances		
Manufacture	3	F
Sales	3	M
Arenas	4	A-3
Asphalt		
Processing and products manufacture	8	H

Table T-1 (cont'd.)
HAZARD INDEX AND USE GROUP CLASSIFICATION

Use of structure	Hazard index number	Use group
Athletic equipment		
Manufacture	3	F
Sales	3	M
Auditoriums	6, 5 or 4	A-1-A, A-1-B, A-3
Automobile & other motor vehicles		
Gasoline service station	2	B
Rental agency within a building	2	B
Repair	3	S-1
Repair incidental to auto sales with limitations	3	S-1
Sales within a building	3	M
Wrecking	3	F
Washing	3	S-1
Awning manufacturer	3	F
Baked goods shop	3	M
Bakeries	3	F
Banks	2	B
Banquet halls	5	A-3
Barber shops	2	B
Beauty shops	2	B
Beverages		
Bottling	3	F
Manufacture		
Alcoholic	8	H
Less than 0.5% alcohol @ 60°	3	F
Bicycle		
Manufacture	3	F
Rental or repair conducted within a building	3	S-1
Sales	3	M
Billiard parlor	4	A-3
Blacksmith shops	3	F
Blueprinting, etc., establishments	3	F
Boarding house	2	R-1 or R-2
Boats or ships		
Building or repair of boats	3	F
Bone distillation	3	F
Bowling alleys	4	A-3
Broom or brush manufacture	3	F
Building materials		
Wholesale business in roofed structures	3	M or S-1
Bus terminals or stations	4	A-3
Business schools or colleges	4	A-4
Camera & other photo equipment		
Manufacture except film sales	3	F
Sales	3	M
Canvas or canvas products		
Manufacture or repair	3	F
Carpet & rug		
Cleaning establishments	8 or 3	H, F
Manufacture or repair	3	F
Catering for outside consumption	3	F

Table T-1 (cont'd.)
HAZARD INDEX AND USE GROUP CLASSIFICATION

Use of structure	Hazard index number	Use group
Cemeteries		
Crematory in cemetery	3	F
Mausoleum, crypt, columbarium	1	S-2
Mortuary chapel in cemetery	4	A-4
Ceramic products manufacture including pottery, small glazed tile, & similar items	3	F
Charcoal, fuel, briquettes, or lampblack manufacture	8	H
Chemicals		
Packaging	8 or 3	H or F depending on nature of materials involved
Manufacture	8 or 3	H or F depending on nature of materials involved
Churches or other places of worship	4	A-4
Circuses, temporary	4	A-3
Cleaning (see Drycleaning & dying; Laundries; Automobiles, washing)		
Clothing		
Manufacturing	8 or 3	H or F depending on nature of materials involved
Rental Establishment	3	M
Retail sales	3	M
Tailoring, custom manufacture or repair (see also Feathers; Felt; Fur; Leather)	3	M
Clubs		
Private	4	A-3 without residence
Nightclubs (see Eating & drinking establishments)		
Coal, coke or tar products, manufacture	8	H
Colleges & universities		
Classroom buildings	4	A-4
Dormitories	2	R-1
Fraternities or sororities	2	R-1
Community centers	4 or 2	A-3 or B
Convalescent homes (see Nursing homes)		
Convents	2	R-1
Cosmetics or toiletries manufacture	8	H
Cotton ginning	8	H
Cotton wadding or linters manufacture	8	H
Courthouses	2 or 4	B or A-3
Crematoriums		
Animal	3	F
Human	3	F
Dance halls	7	A-2
Day care agencies	4	I-2 or A-4
Day nurseries	4	I-2
Dental offices (see Medical & dental)		
Department stores	3	M

Table T-1 (cont'd.)
HAZARD INDEX AND USE GROUP CLASSIFICATION

Use of structure	Hazard index number	Use group
Dormitories	2	R-1 or R-2
Dressmaking shops, custom	8	H
Drinking places (see Eating & drinking establishments)		
Drive-in restaurants	5	A-3
Drive-in theaters	4	A-5
Drug stores	3	M
Dry cleaning & dyeing establishment	8 or 3	H or F depending on solvents used
Dwellings (see Residences)		B
Eating or drinking establishments		
Lunchrooms, restaurants, cafeterias, etc. primarily enclosed	5	A-3
Drive-in	4	A-3
With entertainment or dancing	7	A-2
Electric		
Power or steam generating plants	3	F
Substation	3	F
Electrical appliances, bulbs, wiring supplies, etc.		
Manufacture	3	F
Sales	3	M
Electronic components & supplies		
Manufacture or repair	3	F
Feathers		
Curing, dyeing, washing or bulk processing	8	H
Manufacturing exclusive of above	8	H
Felt		
Curing, dyeing, washing or bulk processing	3	F
Products manufacture, exclusive of above	3	F
Fertilizers, manufacture	8	H
Film, photographic, manufacture	3 or 8	F or H
Storage and studios	3 or 8	F or H
Fire station	2	B
Fish processing	3	F
Florida shops	3	M
Food		
Product processing except meat and fish	3	F
Retail sales	3	M
Fraternities or sororities	2	R-1 or R-2
Funeral establishments	4	A-3
Fur		
Curing, dyeing, finishing, tanning	8	H
Products manufacture exclusive of above	3	F
Garage (see Parking garage)		
Garbage incineration or reduction	3	F
Garden supplies, produce or flowers	3	M
Gas		
Manufacture	8	H
Public utility stations for metering or regulating	2	B

Table T-1 (cont'd.)
HAZARD INDEX AND USE GROUP CLASSIFICATION

Use of structure	Hazard index number	Use group
Storage		
2500 cu. ft. or less	3	S-1
More than 2500 cu. ft.	8	H
Gasoline service stations (see Automobiles)		
Gelatin manufacture	3	F
Generating plants, electric or steam	3	F
Gift shops	3	M
Glass products form previously manufactured	3	F
Glue manufacture	3	F
Golf		
Indoor courses or driving ranges	4	A-3
Gymnasiums	4	A-3
Gypsum manufacture	3	F
Grain storage	8	H
Hair		
Curing, dyeing, washing, bulk processing	3	F
Product manufacture exclusive of above	3	F
Hardware		
Manufacture	3	F
Retail sales	3	M
Hat bodies manufacture	3	F
Helicopter landing facility, rooftop	3	S-1
Home occupations	2	R
Homes for the aged	4	I-2
Hosiery manufacture	3	F
Hospitals		
Including convalescent, nursing or rest homes, and sanitariums, provided custodial care is not provided for drug addicts, alcoholics, mentally ill or mentally deficient	4	I-2
For care of drug addicts, mentally ill or mentally deficient	5	I-1
Research or teaching laboratories (see also Animal hospitals)	2	B
Hotels	2	R-1
Ice manufacture (dry or natural)	3	F
Ice skating rinks	4	A-3
Incineration or reduction of garbage, offal, or dead animals	3	F
Industrial uses (see specific items)		
Without resulting noise, vibration, special danger, hazard, dust, smoke, fumes, etc.	3	F
Other than above	3 or 8	F or H
Ink or inked ribbon manufacture	3	F
Jewelry	3	F
Kennels (see Animal)		
Laboratories		
Research laboratory not accessory to school or hospital	2	B
Scientific research or teaching laboratory, non-profit, accessory to school or hospital subject to limitations	2	B

Table T-1 (cont'd.)
HAZARD INDEX AND USE GROUP CLASSIFICATION

Use of structure	Hazard index number	Use group
Laundries		
Hand laundry	2	B
Self service; pick-up and delivery station of laundry or dry cleaner	2	B
Steam laundries without limitations	3	F
Leather		
Curing, dyeing, finishing or tanning	3	F
Product manufacture exclusive of above	3	F
Libraries	4	A-3
Linoleum or oilcloth manufacture	3	F
Liquor sales, package	3	M
Luggage manufacture	3	F
Lumber (see Wood)		
Manufacturing	3 or 8	F or H
Matches manufacture	8	H
Mattress manufacture and renovation	3	F
Meat		
Markets	3	M
Slaughtering or packaging	3	F
Medical and dental		
Offices	2	B
(See also Laboratories; Orthopedic and medical appliances; Hospitals)		
Meeting hall	4	A-3
Metals, manufacture	3	F
Reduction, refining or smelting	8	H
Monasteries	2	R-1
Motels	2	R-1
Motor freight stations (see Trucking terminals)		
Museums	4	A-3
Musical instruments manufacture	3	F
Newspaper publishing	3	F
Newsstands	3	M
Novelty products manufacture	3	F
Nursing homes	4	I-2
Offices	2	B
Oilcloth manufacture	3	F
Optical equipment or similar precision instruments manufacture	3	F
Orphanages	4	I-2
Orthopedic or medical appliances manufacture	3	F
Paint, turpentine or varnish		
Manufacture	8	H
Spraying booths	8	H
Paper products manufacture	3	F
Parish houses	4	A-3
Parking garages	3	S-1
Petroleum or petroleum products		
Refining	8	H
Storage	3	S-1
Pharmaceutical products manufacture	3	F
Photography studio	2	B
Plastics		
Products manufacture	8	H
Raw, manufacture	8	H

Table T-1 (cont'd.)
HAZARD INDEX AND USE GROUP CLASSIFICATION

Use of structure	Hazard index number	Use group
Police stations	2	B
Pool rooms	2	A-3
Post offices	2	B
Printing		
Plant	3	F
Printing or newspaper publishing	3	F
Prisons & other correctional or detention institutions	5	I-1
Pumping station or substation, water or sewage	2	B
Radio		
Sales	3	M
Studios with audience	5	A-1-B
Studios without audience	2	B
Railroad		
Freight terminal	3	S-1
Passenger station	4	A-3
Recreation		
Center, indoor	4	A-3
Community center building	4	A-3
Rectories	2	R-1
Residences		
One-family	2	R-3
Two-family	2	R-3
Apartment	2	R-2
Temporary dwelling structure	2	R-3
Boarding or lodging house	2	R-1 or R-2
Dormitory	2	R-1 or R-2
Fraternity or sorority	2	R-1 or R-2
Hotel, motel, apartment hotel with accessory services	2	R-1
Convents, monasteries, rectories	2	R-1
Research laboratories (see Laboratories)		
Restaurant, lunch room, cafeteria or other establishment primarily for eating	5	A-3
Retail business	3	M
Stores with combustible or flammable goods constructing a high hazard	8	H
Rubber		
Manufacture (natural or synthetic), including tires, tubes or similar products	8	H
Products (exclusive or processing) including washers, gloves, footwear, bathing caps and like	3	F
Sanatariums		
Not providing custodial care for drug addicts, alcoholics, mentally ill or mentally deficient	4	I-2
Providing care for above	5	I-1
Schools	4	A-4
Seminaries	4 or 2	A-4 & R-1
Settlement houses (depending on nature of activities)	4 or 2	A-3 or B

Table T-1 (cont'd.)
HAZARD INDEX AND USE GROUP CLASSIFICATION

Use of structure	Hazard index number	Use group
Sewage		
Disposal plant	3	F
Pumping station	3	F
Shoddy manufacture	8	H
Shoes		
Manufacture	3	F
Repair shop	2	B
Silverware, manufacture, plate or sterling	3	F
Size manufacture	3	A-3
Skating rinks	4	A-3
Soap and detergents		
Manufacturing, including fat rendering	8	H
Packaging	3	F
Solvent extracting	8	H
Sporting or athletic goods		
Manufacture	3	F
Stores	3	M
Stables	3	S-1
Stadiums	4	A-5
Wholesale business including accessory storage other than flammable liquids, gases and explosives, in roofed structures	3 or 1	S-1 or S-2 depending on nature of materials involved
Stores (see Retail stores; or specific items)		
Tailor shops, custom	2	B
Tanning (see Leather; Fur)		
Taxidermist shops	3	M
Telephone exchanges		
Automatic	2	B
Non-automatic	2	B
Television		
Sales	3	M
Studios	6	A-1a with scenery
	5	A-1b no scenery
	2	B no audience
Textiles		
Manufacture, including knit goods, yard goods, thread or cordage; spinning, weaving, dyeing and printing	3	F
Shoddy, manufacture	8	H
Theaters	6	A-1a with scenery
	5	A-1b no scenery motion picture
Tires, manufacture	8	H
Tobacco products manufacture including curing	3	F
Tools and hardware		
Manufacture	3	F
Sales	3	M
Toys		
Manufacture	3	F
Trailer park (see also Mobile homes)		
Truck		
Repairs	3	S-1
Sales	3	M

Table T-1 (cont'd.)
HAZARD INDEX AND USE GROUP CLASSIFICATION

Use of structure	Hazard index number	Use group
Trucking terminals	3	S-1
Turpentine manufacture	8	H
Warehouses	8, 3 or 1	H, S-1, or S-2 depending on nature of materials involved
Waterpumping stations	2	B
Wax products manufacture	8	H

PART FOUR—ARCHAIC CONSTRUCTION SYSTEMS

T-401.0 Purpose and scope

T-401.1 Purpose: The purpose of this part of Appendix T is to assist the building official and those regulated by this code in evaluating the properties of archaic construction systems.

T-401.2 Scope: This part of Appendix T contains data on construction systems no longer in general use but which may be encountered in older existing buildings. It is meant to be used for assessing existing conditions when evaluating how proposed changes will impact upon the performance of the building.

T-401.3 Application: In any given problem, all available data should be collected and professional judgment exercised in arriving at decisions. Evaluative judgment should be used when test data does not exist or when applying the data contained in this standard.

T-402.0 Archaic fireresistive systems

T-402.1 General: This part of Appendix T contains a list of fireresistive materials and construction which are not necessarily currently in common use. Some of the hourly ratings contained in the listing predate ASTM E-119 that is in current use. The hourly ratings may be higher or lower if tested according to ASTM E-119. In addition to the data contained herein, see Report BMS92, Building Materials and Structures, dated October 7, 1942. National Bureau of Standards. The data listed below is extracted from the Boston Building Code, circa 1943.

T-402.2 Fireresistive materials and construction

T-402.2.1 Minimum qualities: Materials, to be given the fireresistive ratings specified in this part, shall have the following minimum qualities set forth in Sections T-402.2.2 through T-402.2.19.

T-402.2.2 Class 1 concrete: Concrete of Class 1 shall be so proportioned as to have a strength of at least fifteen hundred (1500) pounds per square inch (psi) and the coarse aggregate shall consist of limestone, trap rock, blast furnace slag, cinders containing not more than twenty (20) per cent of combustible material, burned clay or shale.

T-402.2.3 Class 2 concrete: Concrete of Class 2 shall be so proportioned as to have a strength of at least fifteen hundred (1500) pounds psi, the coarse aggregate consisting of sandstone, granite, quartzite, siliceous gravel or other similar material not over one (1) inch in size.

T-402.2.4 Masonry: Masonry shall be laid in lime-cement or cement mortar, or approved masonry cement mortar, except that masonry of gypsum tile shall, and masonry of structural clay tile may, be laid in gypsum mortar. Masonry shall be thoroughly bonded by breaking joints in successive courses or by the use of metal ties.

T-402.2.5 Brick: Brick shall be burned clay or shale, concrete or sand-lime brick of Grade C or better.

T-402.2.6 Stone: Stone shall be limestone, marble, slate or equally fireresistive natural stone. Sandstone, granite or other stone which, because of its crystalline structure or for other reason, is less fireresistive, shall not be considered fire protection for structural metal, but may be used in a masonry wall not less than twelve (12) inches thick required to have fireresistance. Stone masonry shall have the same fireresistive rating as brick masonry.

T-402.2.7 Cast stone: Cast stone masonry shall have the same fireresistive rating as brick masonry.

T-402.2.8 Concrete blocks: Concrete blocks, whether solid or hollow, shall have as coarse aggregate limestone, trap rock, blast furnace slag, cinders containing not more than twenty (20) per cent of combustible material, burned clay or shale.

T-402.2.9 Structural clay tile: Structural clay tile shall conform to the specifications for load-bearing tile, floor tile or partition tile. Where partition tile is specified, load-bearing tile may be used.

T-402.2.10 Gypsum: Gypsum tile or pre-cast gypsum concrete, whether solid or hollow, shall conform to Standard Specifications for Gypsum Partition Tile or Block of the American Society for Testing Materials and shall not contain more than three (3) per cent by weight of wood or other combustible binder or filler.

T-402.2.11 Gypsum concrete: Gypsum concrete shall not contain more than twelve and one-half (12½) per cent by weight of wood or other combustible binder or filler, and shall have a compressive strength of at least five hundred (500) psi. It shall not be used where exposed to the elements.

T-402.2.12 Lath: Expanded metal or wire lath as a base or reinforcement for plastering shall weigh not less than two and two-tenths (2.2) pounds per square yard and shall have not less than two and one-half (2½) meshes per inch.

T-402.2.13 Metal mesh for masonry: Metal mesh reinforcement specified for masonry fire protection of structural metal shall consist of wire lath strips

the full thickness of the masonry, laid in the beds thereof, or its approved equivalent.

T-402.2.14 Metal mesh for concrete: Metal mesh reinforcement specified for concrete fire protection of structural metal shall consist of wire mesh weighing not less than one and one-half (1½) pounds per square yard with wire spaced not over four (4) inches, or not less than no. 11 gage steel wire spaced not over four (4) inches apart, or its approved equivalent.

T-402.2.15 Cement plaster: Cement plaster shall be proportioned of one (1) part Portland cement, and not more than two (2) parts of sand measured by volume dry and loose to which may be added lime putty or hydrated lime not exceeding fifteen (15) per cent of the cement.

T-402.2.16 Gypsum plaster: Gypsum plaster, except where otherwise specified, may contain sand not in excess of three (3) times the weight of the gypsum.

T-402.2.17 Lime plaster: Lime plaster shall consist of a mixture of one (1) part lime, not over three (3) parts sand, and water.

T-402.2.18 Pneumatically projected mortar: Pneumatically projected mortar made of Portland cement, sand and water shall be rated for fire protection the same as Class 1 concrete.

T-402.2.19 Concrete fill: Concrete fill, where specified in this appendix in connection with hollow masonry units shall consist of Class 1 or Class 2 concrete poured in the hollow spaces of the units as they are laid.

T-402.2.20 Reinforced concrete: Portland cement concrete or gypsum concrete poured in place as fire protection for beams, trusses and other horizontal or inclined members of structural steel and pneumatically projected mortar applied to structural steel as fire protection shall be reinforced with metal mesh reinforcement. Concrete protection for vertical columns of structural metal shall have reinforcing consisting of no. 5 wire spaced not over eight (8) inches apart or its equivalent. Reinforcement shall be wrapped around the structural member and so arranged as to be completely embedded in the fire protection material and to ensure its integrity.

T-402.2.21 Reinforced plaster: Plaster used as fire protection or to resist the spread of fire shall be reinforced with metal lath, except plaster less than one (1) inch thick or masonry or concrete.

T-402.2.22 Replacement material: In the protection of structural metal including reinforcement, one-half (½) inch of cement or gypsum plaster may replace an equal thickness of poured concrete or pneumatically projected mortar as protective material; and one (1) inch of cement or gypsum plaster reinforced with metal lath may replace an equal thickness of poured concrete, pneumatically projected mortar or masonry protection.

T-402.2.23 Plaster: Where plaster is required without other specification, it shall consist of one-half (½) inch of cement or gypsum plaster, except that only gypsum plaster shall be used on gypsum masonry.

T-402.2.24 Thickness: In this appendix, except where otherwise specifically stated, the thickness given in a list of materials applies to the next following item only, and not to the total thickness where additional materials are specified.

T-402.2.25 Embedding limitations: Pipes, wires, conduits and ducts shall not be embedded in or placed behind the fire-protective materials required for the protection of structural steel or iron except as otherwise provided in this paragraph. Above fire-protective hung ceilings and within the enclosed space in buildings of Type 1 and Type 2 construction, within which, other than the enclosure, fire protection of steel is not required, pipes, wires, conduits and ducts may be placed, provided they are so arranged and so secured that they will not, either by expanding in the event of fire, or otherwise impair, the effectiveness of the enclosing protective materials. Electric conduits and wires and gas pipes may be embedded in concrete or masonry fire protection of structural steel where the protective material is reinforced with wire mesh, provided they shall have protective covering except over the tops of beams and girders, at least as thick as required for the steel.

T-402.2.26 Damage protection: In factories, garages, warehouses and other buildings in which the fire-protective covering required for steel or iron columns may be damaged by the movement of vehicles, materials or equipment, such covering shall be protected by metal or other material in a manner satisfactory to the building official.

T-402.2.7 Firestopping: Firestopping shall mean the stopping-off or enclosure at the ends and wherever else specified of the spaces between studs of partitions, joists of floors and roofs and other similar spaces to prevent drafts of air and the communication of fire from one such space to another. Firestopping shall consist of wood not less than one and one-half (1½) inches thick, of sheet metal not less than no. 24 gage or of masonry, or a combination of such materials. Firestopping shall be tightly fitted in the space to be filled, about pipes, wires and ducts and, if cut or disturbed in the placement of pipes, wires and ducts, shall be repaired.

T-402.3 Fire protection of steel columns

T-402.3.1 Protective thickness: Structural steel columns required to have fire protection of a given rating shall be covered on all sides with protective material having not less than the thickness necessary for the required rating. Except where "no fill" is specified, re-entrant and other accessible spaces behind the specified outer protection shall be filled with concrete or brick masonry or the material of the outer protection.

T-402.3.2 Fireresistance rating: Materials shall be assumed to afford to steel columns fire protection of the rating indicated in the following Sections T-402.3.3 through T-402.3.6.

T-402.3.3 Four-hour rating

1. Two (2) inches Class 1 concrete.
2. Three (3) inches Class 2 concrete, metal mesh reinforcement.
3. Three and one-half (3½) inches brick masonry.

4. Two (2) layers two (2) inch structural clay partition tile masonry, metal mesh in beds.
5. Two (2) inches structural clay partition tile masonry, concrete fill, metal mesh in beds, three-fourths (¾) inch gypsum plaster.
6. Four (4) inches structural clay partition tile masonry, concrete fill, metal mesh in beds, five-eighths (⅝) inch lime plaster.
7. Four (4) inches structural clay partition tile or concrete block masonry, concrete fill, plaster.
8. Three (3) inches hollow gypsum tile masonry and plaster.
9. Two (2) inches gypsum concrete, metal mesh reinforcement.
10. Two (2) inches solid gypsum tile masonry and plaster.
11. Three (3) inches solid cinder concrete block masonry and plaster.
12. Four (4) inches hollow cinder concrete block masonry and plaster.

T-402.3.4 Three-hour rating

1. One and three-fourths (1¾) inches Class 1 concrete.
2. Two (2) inches Class 2 concrete, metal mesh reinforcement.
3. Two (2) inches gypsum concrete.
4. Two (2) inches solid cinder concrete block masonry and plaster.
5. Two (2) inches structural clay partition tile masonry, concrete fill.

T-402.3.5 Two-hour rating

1. One and one-half (1½) inches Class 1 concrete.
2. Two (2) inches Class 2 concrete, metal mesh reinforcement.
3. One (1) inch Class 1 or Class 2 concrete encased in standard weight steel or wrought iron pipe.
4. Two (2) inches structural clay partition tile masonry and plaster.
5. Two (2) layers plaster, each on metal lath, with three-fourths (¾) inch air space between, two (2) inches total thickness.
6. Two (2) inches gypsum concrete.
7. Two (2) inches solid or three (3) inches hollow gypsum tile masonry.

T-402.3.6 One-hour rating

1. One (1) inch Class 1 concrete.
2. One and one-half (1½) inches Class 2 concrete with metal mesh reinforcement.
3. Two and one-fourth (2¼) inches brick masonry.
4. Two (2) inches structural clay partition tile or concrete block masonry.
5. One (1) inch cement or gypsum plaster on metal lath.

T-402.3.7 Thickness: The thickness of protection on the outer edges of lugs or brackets need not exceed one (1) inch.

T-402.4 Fire protection of cast iron columns

T-402.4.1 Protective thickness: Cast iron columns required to have fire protection of a given rating shall be covered on all sides with protective materials having not less than the thickness necessary for the required rating. Re-entrant spaces, if any, on the exterior of cast iron columns, and other accessible spaces behind the specified protection, shall be filled with Class 1 concrete or brick masonry or the material of the outer protection.

T-402.4.2 Fireresistance rating: Materials shall be assumed to afford to cast iron columns fire protection of the rating indicated in the following Sections T-402.4.3 through T-402.4.5.

T-402.4.3 Four-hour rating: Cast iron columns shall not be used where the protection of a four-hour rating is required.

T-402.4.4 Three-hour rating

1. Two (2) inches Class 1 concrete.
2. Three (3) inches Class 2 concrete, metal mesh reinforcement.
3. Two (2) inches structural clay partition tile or concrete block masonry concrete fill.
4. One and one-half (1½) inches cement or gypsum plaster on metal lath and metal furring to form one-half (½) inch air space.
5. One and one-half (1½) inches Class 1 concrete.
6. Two (2) inches Class 2 concrete with metal mesh reinforcement.

T-404.4.5 One-hour rating

1. One (1) inch Class 1 concrete.
2. One and one-half (1½) inches Class 2 concrete with metal mesh reinforcement.
3. One (1) inch cement or gypsum plaster on metal lath.

T-404.5 Fire protection of steel in reinforced concrete columns

T-404.5.1 Protective thickness: The main steel reinforcement, including spiral reinforcement and ties larger than one-half (½) inch, in reinforced concrete columns required to have fire protection of a given rating shall be covered with concrete having not less than the thickness listed in this section for the rating indicated in the following Sections T-404.5.2 through T-404.5.6.

T-404.5.2 Four-hour rating

1. One and one-half (1½) inches Class 1 concrete.
2. Two (2) inches Class 2 concrete.

T-404.5.3 Three-hour rating: One and one-half (1½) inches Class 1 or Class 2 concrete.

T-404.5.4 Two-hour rating

1. One (1) inch Class 1 concrete.
2. One and one-half (1½) inches Class 2 concrete.

T-404.5.5 One-hour rating: One (1) inch Class 1 or Class 2 concrete.

T-404.5.6 Ties less than one-half inch: The thickness of protection on column ties not larger than one-half (½) inch may be one-half (½) inch thinner than that listed above.

T-404.6 Fire protection of steel beams, girders and trusses

T-404.6.1 Protective thickness: Steel beams, girders and trusses or the members of trusses, required to have fire protection of a given rating, shall be covered on all sides with material having not less than the thickness necessary for the required rating.

T-404.6.2 Fireresistance rating: Materials shall be assumed to afford steel beams, girders and trusses, or the members thereof, fire protection of the rating indicated in the following Sections T-404.6.3 through T-404.6.6.

T-404.6.3 Four-hour rating

1. Two (2) inches Class 1 concrete.
2. Three (3) inches Class 2 concrete.
3. Three (3) inches structural clay partition tile or concrete block masonry and plaster.
4. Three (3) inches hollow gypsum tile masonry and plaster.
5. Two (2) inches gypsum concrete.
6. Two (2) inches solid gypsum tile masonry and plaster.

T-404.6.4 Three-hour rating

1. One and three-quarters (1¾) inches Class 1 concrete.
2. Two and one-half (2½) inches Class 2 concrete.
3. Two (2) inches gypsum concrete.
4. Two (2) inches structural clay partition tile, or concrete block masonry and plaster.
5. Two (2) inches solid, or three (3) inches hollow gypsum tile masonry.

T-404.6.5 Two-hour rating

1. One and one-half (1½) inches Class 1 concrete.
2. Two (2) inches gypsum concrete.

T-404.6.6 One-hour rating

1. One (1) inch Class 1 concrete.
2. One and one-half (1½) inches Class 2 concrete.
3. Seven-eighths (⅞) inch or cement or gypsum plaster on metal lath.

T-404.7 Fire-protection of steel in reinforced concrete beams

T-404.7.1 Protective thickness: The main steel reinforcement, including stirrups larger than one-half (½) inch, in reinforced concrete beams, girders and trusses, including the ribs of reinforced concrete ribbed floors or roofs where one or both sides of the ribs, in addition to the soffit, are exposed to fire, required to have fire protection of a given rating, shall be covered on all sides with concrete having not less than the thickness listed in this section for the required rating. Where a reinforced concrete floor or roof has a flush ceiling formed with approved permanent masonry fillers between ribs, the reinforcement shall have the protection required for reinforcing steel of floors and roofs in Section T-404.8.

T-404.7.2 Four-hour rating

1. One and one-half (1½) inches Class 1 concrete.
2. Two (2) inches Class 2 concrete.

T-404.7.3 Three-hour rating: One and one-half (1½) inches Class 1 or Class 2 concrete.

T-404.7.4 Two-hour rating

1. One (1) inch Class 1 concrete.
2. One and one-half (1½) inches Class 2 concrete.

T-404.7.5 One-hour rating: One (1) inch Class 1 or Class 2 concrete.

T-404.7.6 Stirrups less than one-half inch: The thickness of protection on stirrups not larger than one-half (½) inch may be less than that listed by not more than one-half (½) inch.

T-404.8 Fire protection of steel reinforcing in floors and roofs

T-404.8.1 Protective thickness: The steel reinforcement in reinforced concrete floors and roofs with flush or plane ceilings, such that the exposure to fire is on the soffit only, required to have fire protection of a given rating, shall be covered with concrete having not less than the thickness listed in this section for the required rating. In floors or roofs having reinforced concrete ribs where the concrete surrounding the steel reinforcement is exposed to fire on one or both sides in addition to the soffit, such reinforcement shall have the protection specified in Section T-404.7 for steel in reinforced concrete beams.

T-404.8.2 Four-hour rating

1. One (1) inch Class 1 concrete.
2. One and one-fourth (1¼) inches Class 2 concrete.

T-404.8.3 Three-hour rating: One (1) inch Class 1 or Class 2 concrete.

T-404.8.4 Two-hour rating

1. Three-fourths (¾) inch Class 1 concrete.
2. One (1) inch Class 2 concrete.

T-404.8.5 One-hour rating: Three-fourths (¾) inch Class 1 or Class 2 concrete.

T-404.9 Fireresistive floor and roof construction

T-404.9.1 Protective thickness: Floors and roofs required to have resistance of a given rating to the spread of fire shall have such thickness of the materials of which it is constructed, as shall be necessary for the required rating, and structural metal forming a part of such floors or roofs shall have protection against fire of such required rating. Floors and roofs required to have two (2) hour or longer resistance to fire shall be constructed of noncombustible materials. Granolithic, burned clay tile, ceramic tile or other similar incombustible floor finish of a given thickness may be substituted for an equal thickness, and sand, cinder or other incombustible filling material, with or without embedded wooden screeds, may be substituted for two-thirds (⅔) its thickness, of the floor or roof construction material specified in this section, provided that such floors and roofs shall have adequate thickness for structural purposes.

T-404.9.2 Fireresistance rating: Floor or roof construction shall be assumed to afford resistance to the spread of fire of the rating indicated in the following sections T-404.9.3 through T-404.9.6.

T-404.9.3 Four-hour rating

1. Four (4) inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.

2. Four (4) inches solid masonry arches or slabs.
3. Four (4) inches structural clay floor tile masonry arches or slabs with top covering of not less than two (2) inches of solid masonry or reinforced concrete.
4. Five (5) inches combination reinforced Portland cement concrete slab consisting of permanent fillers of concrete, block, gypsum or structural clay tile and one and one-half (1½) inches of concrete topping; but if structural clay partition tiles are used for fillers they shall be plastered on the soffit.

T-404.9.4 Three-hour rating

1. Three (3) inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.
2. Three (3) inches solid masonry arches or slabs.
3. Four (4) inches structural clay floor tile masonry, arches or slabs with top covering of not less than one and one-half (1½) inches of solid masonry or reinforced concrete.
4. Four (4) inches combination reinforced Portland cement concrete slab consisting of permanent fillers of concrete block, gypsum or structural clay tile and one (1) inch concrete topping; but if structural clay partition tiles are used for fillers, they shall be plastered on the soffit.

T-404.9.5 Two-hour rating

1. Two and one-half (2½) inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.
2. Two and one-half (2½) inches solid masonry arches or slabs.
3. Three (3) inches structural clay floor tile masonry, arches or slabs with top covering of not less than one (1) inch of solid masonry or reinforced concrete.

T-404.9.6 One-hour rating

1. Three (3) inches structural clay floor tile masonry, arches or slabs with all joints thoroughly filled with cement or gypsum mortar.
2. Wood floor or roof construction with joists not less than one and five-eights (1⅝) inches in least dimension, firestopped, double board floor, approved asbestos felt between layers of boards, and with a ceiling of at least three-quarters (¾) inch cement or gypsum plaster on metal lath.
3. Steel beams or steel joists not more than thirty-six (36) inches apart on centers with noncombustible floor and a ceiling of at least three-quarters (¾) inch cement or gypsum plaster on metal lath metal furring.

T-404.10 Fireresistive ceiling construction

T-404.10.1 Protective thickness: Ceilings required to afford fire protection of a given rating to the floor or roof framing under which it is supported shall be of fireresistive materials of at least the thickness necessary for the given rating. A fireresistive ceiling and all hangers and fastenings necessary for its support to the protected framing shall be of noncombustible materials. It shall be capable of sustaining its own weight without exceeding allowable stresses. Metal reinforcement in such a ceiling shall be protected from fire as specified in Section T-404.8 for reinforcing in a floor.

T-404.10.2 Fireresistance rating: Ceiling construction shall be assumed to afford to floor or roof framing fire protection of the rating indicated in the following Sections T-404.10.3 through T-404.10.6.

T-404.10.3 Four-hour rating

1. Two and one-half (2½) inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.
2. Two (2) inches precast reinforced gypsum concrete, plastered.

T-404.10.4 Three-hour rating

1. Two (2) inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.
2. Two (2) inches precast reinforced gypsum concrete, lapped or rabbeted joints.

T-404.10.5 Two-hour rating: One and one-half (1½) inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.

T-404.10.6 One-hour rating: Three quarter (¾) inch cement or gypsum plaster on metal lath.

T-404.11 Fireresistive bearing walls and partitions

T-404.11.1 Protective thickness: Bearing walls and partitions required to have resistance to fire or the spread of fire of a given rating shall be constructed of fireresistive materials and shall have at least the thickness necessary for the required rating. Walls required to have two (2) hour or longer rating shall be of noncombustible materials. Steel reinforcement in reinforced concrete walls shall have the same protection for the given rating as is required in Section T-404.9 for floors.

T-404.11.2 Fireresistance rating: Bearing walls and partitions shall be assumed to have resistance to fire and the spread of fire of the rating indicated in the following Sections T-404.11.3 through T-404.11.6.

T-404.11.3 Four-hour rating

1. Eight (8) inches solid brick masonry.
2. Twelve (12) inches hollow wall of brick masonry, minimum eight (8) inch masonry thickness.
3. Twelve (12) inches structural clay load-bearing tile masonry with two (2) units and not less than three (3) cells in the thickness of the wall.
4. Eight (8) inches structural clay load-bearing tile masonry with one (1) unit and not less than two (2) cells in the thickness of the wall, plastered both sides.
5. Twelve (12) inches concrete block masonry with one (1) unit and not less than two (2) cells in the thickness of the wall.
6. Eight (8) inches one (1) piece concrete block masonry with shells and webs at least one and one-half (1½) inches thick, plastered both sides.
7. Twelve (12) inches total thickness of brick masonry facing bonded to structural clay load-bearing tile masonry backing.
8. Eight (8) inches solid concrete.
9. Six (6) inches solid reinforced concrete.

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10. A steel or reinforced concrete frame bearing wall in which the steel has fire protection of four (4) hour rating, with panel filling as specified in Section T-404.12 for a non-bearing wall of four (4) hour rating.

T-404.11.4 Three-hour rating

1. Eight (8) inches structural clay load-bearing tile masonry with two (2) units and not less than four (4) cells in the thickness of the wall.
2. Twelve (12) inches structural clay load-bearing tile masonry with one (1) unit and not less than three (3) cells in the thickness of the wall.
3. Eight (8) inches one (1) piece concrete block masonry with shells and webs not less than one and one-half (1½) inches thick, plastered both sides.
4. Eight (8) inches one (1) piece concrete block masonry with shells and webs not less than two (2) inches thick.
5. Five (5) inches solid reinforced concrete.
6. A steel or reinforced concrete frame bearing wall in which the steel has fire protection of three (3) hour rating, with panel filling as specified in Section T-404.12 for a non-bearing wall of three (3) hour rating.

T-404.11.5 Two-hour rating

1. Eight (8) inches structural clay load-bearing tile masonry with not less than three (3) cells in the thickness of the wall.
2. Eight (8) inches concrete block masonry with shells and webs not less than one and one-half (1½) inches thick.
3. A steel or reinforced conrete frame bearing wall in which the steel has fire protection of two (2) hour rating, with panel filling as specified in Section T-404.12 for a non-bearing wall of two (2) hour rating.

T-404.11.6 One-hour rating

1. A steel or wooden stud bearing wall covered on both sides with one (1) inch cement or gypsum plaster on metal lath, firestopped if of wood.
2. A steel or reinforced concrete frame bearing wall in which the steel has fire protection of one (1) hour rating, with panel filling as specified in Section T-404.12 for a non-bearing wall of one (1) hour rating.

T-404.12 Fireresistive non-bearing walls and partitions

T-404.12.1 Protective thickness: Non-bearing walls and partitions required to have resistance to fire and the spread of fire of a given rating shall be constructed of fireresistive materials and shall have at least the thickness necessary for the required rating. Walls required to have two (2) hour or longer rating shall be of incombustible materials. Steel reinforcement in reinforced concrete walls shall have the same protection for the given rating as is required in Section T-404.8 for steel in floors.

T-404.12.2 Fireresistance rating: Non-bearing walls and partitions shall be assumed to have resistance to fire and the spread of fire of the rating indicated in the following Sections T-404.12.3 through T-404.12.6.

T-404.12.3 Four-hour rating

1. Eight (8) inches solid brick masonry.
2. Three and one-half (3½) inches solid brick masonry, plastered both sides.
3. Six (6) inches structural clay load-bearing tile, plastered both sides.
4. Six (6) inches solid concrete.
5. Four (4) inches solid reinforced concrete.
6. Any wall which, as a bearing wall, has a three (3) hour or four (4) hour rating in Section T-404.11, except the steel or reinforced concrete frame bearing wall.

T-404.12.4 Three-hour rating

1. Three and one-half (3½) inches solid brick masonry.
2. Four (4) inches structural clay load-bearing tile, plastered both sides.
3. Four (4) inches solid concrete.
4. Three (3) inches reinforced concrete.
5. Any wall which, as a bearing wall, has a two (2) hour rating in Section T-404.11 except the steel or reinforced concrete frame bearing wall.

T-404.12.5 Two-hour rating

1. Three (3) inches gypsum tile masonry plastered both sides except in exterior walls.
2. Eight (8) inches structural clay partition tile masonry, plastered both sides.
3. Eight (8) inches structural clay load-bearing tile, with three (3) cells in the thickness of the wall.
4. Four (4) inches concrete block plastered both sides.
5. Two (2) inches solid neat, fibered, gypsum plaster on metal lath and noncombustible studding.

T-404.12.6 One-hour rating

1. Three (3) inches gypsum tile masonry.
2. Two (2) inches solid gypsum tile masonry plastered both sides.
3. Three (3) inches structural clay partition tile plastered both sides.
4. Two and one-half (2½) inches solid cement or sanded gypsum plaster on metal lath and noncombustible studding.
5. Three (3) inches total thickness of hollow wall, three-quarter (¾) inch cement or gypsum plaster on metal lath and noncombustible studding.
6. Three (3) inches total thickness of hollow wall, three-quarter (¾) inch cement or gypsum plaster on metal lath and wooden studding, firestopped.

T-404.13 Fireresistive doors

T-404.13.1 General: Doors which are required to be fire doors, fireresistive doors, or of fireresistive construction shall conform to the requirements of this section and Section T-404.14.

T-404.13.2 Classification: Fire doors shall be classified for the purposes of of this code as Class A, Class B, and Class C.

T-404.13.3 Class A fire doors: Class A fire doors shall be doors of the following construction and as specified in Section T-404.14.

1. Tin-clad, three (3) ply wood core, sliding.

2. Tin-clad, three (3) ply wood core, swinging single leaf, doorway not over six (6) feet wide.
3. Tin-clad, three (3) ply wood core, swinging in pairs, doorway not over ten (10) feet wide.
4. Hollow metal, swinging single leaf, doorway not over four (4) feet wide.
5. Hollow metal, swinging in pairs, doorway not over eight (8) feet wide.
6. Sheet metal, sliding, single, doorway not over ten (10) feet wide.
7. Sheet metal, sliding in pairs, doorway not over twelve (12) feet wide.
8. Sheet metal, swinging single leaf, doorway not over six (6) feet wide.
9. Sheet metal, swinging in pairs, doorway not over ten (10) feet wide.
10. Steel rolling doorway not over twelve (12) feet wide.
11. Steel plate, doorway not over four (4) feet wide.
12. Any other construction equal or superior to a tin-clad three (3) ply wood core door in a standard fire test, for resistance to fire, the spread of fire and smoke, and transmission of heat.

T-404.13.4 Class B fire doors: Class B fire doors shall be doors of the following construction and as specified in Section T-404.14.

1. Tin-clad, three (3) ply wood core.
2. Tin-clad, two (2) ply wood core, sliding, doorway not over ten (10) feet wide.
3. Tin-clad, two (2) ply wood core, swinging single leaf, doorway not over six (6) feet wide.
4. Tin-clad, two (2) ply wood core, swinging in pairs, doorway not over ten (10) feet wide.
5. Hollow metal, sliding, doorway not over eight (8) feet wide.
6. Metal-clad, paneled, swinging single leaf, doorway not over three (3) feet wide.
7. Metal-clad, paneled, swinging in pairs, doorway not over six (6) feet wide.
8. Any other construction equal or superior to a tin-clad two (2) ply wood core door in a standard fire test, for resistance to fire, the spread of fire and smoke, and transmission of heat.

T-404.13.5 Class C fire doors: Class C Fire doors shall be doors of the following construction and as specified in Section T-404.14.

1. Metal-clad, paneled, swinging single leaf, doorway not over four (4) feet wide.
2. Metal-clad, paneled, swinging in pairs, doorway not over eight (8) feet wide.

T-404.13.6 Substitution: A Class A door may be used where Class B or Class C is specified; a Class B door may be used where Class C is specified. Two (2) Class B or Class C doors on opposite sides of the wall may be used where a single Class A or Class B door is specified.

T-404.13.7 Overlap: Fireresistive doors, when closed, shall completely cover the doorways in the walls and partitions or the openings in the floors or roofs to which they are fitted. A swinging fire door shall either overlap both jambs and the head of the opening not less than four (4) inches or be fitted to a fireresistive frame with a rabbet the full thickness of the door and with not less than one half (½) inch overlap on the door. A sliding fire door, except in enclosures about passenger elevators, shall overlap both jambs and the head of the opening not less than four (4) inches. A sliding fire door in an enclosure about a passenger elevator shall overlap jambs, head and adjoining panels not less than one half (½) inch. Fire doors shall fit closely at the floor with clearance of not over one quarter (¼) inch.

T-404.13.8 Thresholds: In buildings with combustible floors, doorways required to have fire doors shall have noncombustible thresholds the full thickness of the wall, extending at least four (4) inches from the face of the wall where a door is hung and extending laterally at least six (6) inches behind each jamb of the doorway. Thresholds may be flush with the floor.

T-404.13.9 Rabbetted frame: The rabbetted frame of a swinging fire door shall be constructed of structural steel built into the concrete, masonry or other fireresistive material of the wall about the opening and secured thereto, except that the rabbeted frame of a Class B or Class C door may be of wood, covered with sheet metal not less than no. 26 gage in thickness, secured to the wall in the opening.

T-404.13.10 Fit: Fire doors when closed shall fit tightly against the wall or frame so as to provide an effective stop for fire and smoke. Except for the metal-covered wooden frame specified in this section, combustible material shall not intervene between the door and the fireresistive material of the wall, floor or roof to which it is fitted.

T-404.13.11 Hardware: Hinge hardware for fire doors shall be of malleable iron or rolled structural steel not less than one quarter (¼) inch thick except that tubular steel track for sliding doors may be not less than one eight (⅛) inch thick. Equivalent thickness of solid bronze or brass may be used. Fire doors shall not depend upon cords, cables or chains to support them in closed position except in elevator shafts.

T-404.13.12 Tracks: Tracks for sliding fire doors shall be so supported that a track hanger comes at each door hanger when the door is closed. Track hangers shall be secured to wood stud walls by screws or bolts, to steel stud walls by bolts or rivets, to masonry walls by through bolts and to concrete walls by through bolts or approved built-in inserts. Expansion shields shall not be used to support fire doors.

T-404.13.13 Hinges: Hinges for swinging fire doors, except in wooden stud walls, shall be riveted or through-bolted to the structural steel frame of the opening, through-bolted to the wall if of masory or concrete or secured by approved inserts in the concrete or built into masonry in an approved manner.

T-404.13.14 Strap hinges: Strap hinges and sliding door hangers shall be secured to fire doors by through-bolting, riveting or welding. Swinging fire doors in rabbeted frames, except tin-clad, wood core doors, may be hung on butts. Other swinging fire doors shall have strap hinges.

T-404.13.15 Straps, locks and latches: Sliding fire doors shall have adequate stops for the closed position. Swinging Class A fire doors shall have surface

latches or unit locks. Class B and Class C doors shall have surface latches, unit or mortise locks. The latch bolts of unit or mortise locks on fire doors shall have a throw of three quarters (¾) inch. When mounted in pairs, fire doors shall be rabbeted by means of an astragal or otherwise where they come together. One of a pair of swinging fire doors shall have push bolts at top and bottom with a throw of three quarters (¾) inch and the other shall be held by latch to the first.

T-404.13.16 Opening hardware: Except in detention buildings, fire doors hung in required exits shall be so fitted with hardware that they can be opened from inside without use of a key when the building is occupied.

T-404.14 Fire door construction

T-404.14.1 Fastening: In the construction of fire doors, solder shall not be used except for filling joints. Sheet metal shall be fastened to wood by nailing and to metal frame by bolting, riveting or welding.

T-404.14.2 Glass: Class A doors shall not have glass panels. Class B doors may have glass panels not larger than one hundred (100) square inches in exposed area nor more than twelve (12) inches in width or height. Class C doors may have glass panels not larger than two thousand and sixteen (2,016) square inches in total exposed area, and any single light shall not have an exposed area exceeding twelve hundred and ninety-six (1,296) square inches. Glass in fire doors shall be wire glass not less than one quarter (¼) inch thick and shall be set five eighths (⅝) inch in grooves three quarters (¾) of an inch deep.

T-404.14.4 Tin-clad, two-ply: Tin-clad, two-ply wood core doors shall be constructed in accordance with the specifications of the National Board of Fire Underwriters for such doors in Class B openings and shall bear the label of the Underwriters Laboratories to this effect.

T-404.14.4 Tin-clad, two-ply: Tin-clad, two-ply wood core doors shall be constructed in accordance with the specifications of the National Board of Fire Underwriters for such doors in Class B openings and shall bear the label of the Underwriters Laboratories to this effect.

T-404.14.5 Hollow metals: Hollow metal doors shall have substantial stiles and rails of heavy pressed steel, reinforced for hinges and other hardware. Panels shall be of sheet steel filled with asbestos board or other approved insulating materials. The door shall be assembled by welding or riveting.

T-404.14.6 Sheet metals: Sheet metal doors shall be constructed with a rolled steel rigid frame covered both sides with one sixteenth (1/16) inch asbestos board and no. 26 gage corrugated sheet metal, with corrugations vertical on one side and horizontal on the other, bound on the edges with rolled steel or pressed steel shapes.

T-404.14.7 Steel rolling: A steel rolling fire door shall be constructed of sheet steel interlocking slats, sliding in grooves, counterweighted by springs, with the roller and mechanism enclosed in heavy sheet metal.

T-404.14.8 Steel plate: A steel plate fire door shall be constructed of not less than no. 12 gage steel plate mounted on a rolled steel frame, assembled by welding or riveting.

T-404.14.9 Metal clad: A metal clad, paneled fire door shall have a wood core with stiles and rails not less than one and three quarters (1¾) inches thick covered with no. 26 gage sheet steel; panels three quarters (¾) inch thick covered with no. 26 gage sheet steel, set three quarters (¾) inch in grooves; joints of metal lapped and well nailed.

T-404.14.10 Class A label: A door properly bearing the Underwriters' label certifying that it is suitable for the protection of a Class A opening shall be acceptable as a Class A door.

T-404.14.11 Class B label: A door properly bearing the Underwriters' label certifying that it is suitable for the protection of a Class B opening shall be acceptable as a Class B door, except that metal clad doors wider than three (3) feet shall not be accepted as Class B doors.

T-404.14.12 Class C label: A door properly bearing the Underwriters' label certifying that it is suitable for the protection of a Class C opening shall be acceptable as a Class C door.

T-404.15 Fireresistive shutters: Shutters required to be fire shutters or fireresistive shutters shall be constructed and hung as specified for Class B fireresistive doors in Sections T-404.13 and T-404.14.

T-404.16 Fireresistive windows

T-404.16.1 General: Windows which are required to be fire windows, fireresistive windows, or of fireresistive construction shall conform to the requirements of this section.

T-404.16.2 Movable: Fireresistive windows may be fixed or arranged to open and close. Fixed fireresistive windows shall be so secured in the walls in which they are placed that they may expand in case of fire without buckling. Movable fireresistive windows shall be opened or closed in one of the following manners.

1. One (1) or more sashes may slide horizontally in a fireresistive frame.
2. One (1) or more sashes may slide vertically with counterweights or with two (2) sashes counterbalanced and hung on chains. If a sash is closed in raised position it shall have a fastening.
3. A sash may be hinged at top, bottom, or either side.
4. A sash may be pivoted at top and bottom or at the sides.
5. A sash may be arranged to open and close in any other approved manner, with approved hardware.

T-404.16.3 Sash: Movable sashs in fireresistive windows shall be fitted to fireresistive frames of the same or similar construction. Both sashes and frames, and metal mullions between window units, shall be so fitted in the walls in which they are placed as to be continuous with the fireresistive material of the wall and so secured that they may expand in case of fire without buckling.

T-404.16.4 Glass: Glass in fireresistive windows shall be wired glass not less than one quarter (¼) inch thick and the area of a single light shall not exceed

seven hundred and twenty (720) square inches. Glass shall be set three eights (⅜) inch in grooves at least one half (½) inch deep. Glass shall be secured by glazing angles or moldings screwed to the sash and forming continuous grooves for the glass.

T-404.16.5 Construction: Fireresistive windows shall be of the following construction.

1. Hollow sheet metal sashes and frames fabricated by pressing, welding, riveting or crimping without the use of solder or other fusible alloy, except for filling joints, and bearing the label of Underwriters' Laboratories.
2. Rolled steel or pressed steel sashes fabricated by pressing, welding, riveting or crimping, of a make and style approved by the commissioner.
3. Any other approved constructions as fireresistive as that specified in item 1 above.

T-404.16.6 Hollow sheet metal: Fired fireresistive windows of hollow sheet metal construction shall not exceed seven (7) feet in width nor ten (10) feet in height. Fireresistive windows of hollow sheet metal construction with movable sashes shall not exceed six (6) feet in width nor ten (10) feet in height.

T-404.16.7 Rolled steel: Fireresistive windows of rolled steel construction shall not exceed eighty-four (84) square feet in area nor twelve (12) feet in either height or width.

T-404.16.8 Wind pressure: Fireresistive windows and their fastenings shall be capable of resisting the wind pressure on the wall of the building applied either on the inside or the outside of the window without exceeding allowable stresses.

T-404.16.9 Substitution: Where fireresistive windows are required, wooden windows and plain glass may be substituted provided the openings are protected by fireresistive doors or shutters, or, in buildings of approved occupancy and construction, by an approved system of open sprinklers.

T-404.17 Fireresistive roof covering

T-404.17.1 Classification: Roof covering allowed under this code shall be classified as fire-retardant or ordinary, according to resistance to fire outside, as provided in this section. Fire-retardant roof covering is the more fireresistive and may be used on any building. Ordinary roof covering shall not be used where fire-retardant roofing is specified. Roof covering less fireresistive than ordinary roof covering shall not be used on any building.

T-404.17.2 Fire-retardant roofing: Fire-retardant roofing shall be any roof covering meets the requirements of Class A or Class B roofing under the specifications of the Underwriters' Laboratories, Inc. The following roof covering shall be assumed to meet the requirements for fire-retardant roofing.

1. Built up roofing consisting of successive layers of roofing felt impregnated with asphalt; a final layer of asphalt in which, while molten, is embedded a continuous layer of roofing gravel or slag.
2. Built up roofing consisting of successive layers of roofing felt impregnated with coal tar; a final layer of tar in which, while molten, is embedded a continuous layer of roofing gravel or slag.
3. Built up roofing consisting of successive layers of roofing felt impregnated with asphalt; a final layer of asbestos roofing felt impregnated with asphalt weighing not less than fourteen (14) pounds per hundred square feet, or a final layer of asphalt-saturated prepared roofing coated with granulated slate or other similar material.
4. Built up roofing consisting of successive layers of roofing felt impregnated with tar or asphalt and a finish of burned clay floor tile, stone flagging, cement concrete or other similar material.
5. Sheet metal with locked and soldered joints not less than no. 26 gage in thickness.
6. Shingles of natural slate.
7. Shingles of burned clay tile.
8. Shingles of sheet metal not less than no. 26 gage in thickness.
9. Shingles of asbestos board not less than one-eighth (⅛) inch thick.
10. Shingles of asphalt saturated felt surfaced with granulated slate or other similar material and carrying the Underwriters Class "C" label.
11. Corrugated sheet metal with lapped joints not less than no. 26 gage in thickness.
12. Corrugated asbestos board not less than three-sixteenths (3/16) inch thick.

T-404.17.3 Ordinary roofing: Ordinary roofing shall be any roof covering which meets the requirements of Class C roofing under the specifications of the Underwriters' Laboratories, Inc. The following roof covering shall be assumed to meet the requirements for ordinary roofing.

1. Built up roofing consisting of successive layers of roofing felt impregnated with asphalt, coal tar or other approved material, not equal in fireresistance to a fire-retardant roofing.
2. Prepared roofing consisting of felt or fabric impregnated or coated, or both, with asphalt, tar or other approved material or shingles of such prepared roofing, not equal in fireresistance to fire-retardant roofing.
3. Canvas stretched tightly and coated with paint.

T-404.17.4 Means of securing: Built-up roofing shall be secured to the roof deck in the following manner:

1. Over masonry slab, the first layer shall be laid in molten asphalt or tar mopped on the roof deck, after the deck is properly primed, or by nailing a layer of building paper to nailing blocks other than wood placed in the deck.
2. Over wood decks, the built-up roofing shall be secured by nailing a layer of building paper to the roof deck over which the prepared roofing is to be laid with the first layer laid in molten asphalt or tar.
3. Roofings other than built-up roofings, such as shingles, slates, and tile roll roofing shall be well secured to the deck by nailing, bolting, wiring, or other approved methods.

APPENDIX 9

City of Los Angeles Rule of General Application on Structural Changes Required by Change of Occupancy

SUBJECT: STRUCTURAL CHANGES REQUIRED BY CHANGE OF OCCUPANCY OR INCREASE IN OCCUPANT LOAD

Changes of Occupancy

Section 91.0315(b) requires a building be made to conform in all respects whenever the occupancy is changed to a different subgroup.

Section 91.0315(b) allows the Superintendent to issue a new certificate without requiring complete compliance if he finds that the change in occupancy will result in no increased hazards to life, limb, health, property, or public welfare. Under this authority, changes of occupancy may be made without establishing that a building complies with current structural requirements of the Building Code under any of the following conditions:

1. In buildings constructed on or after October 6, 1922, a change in occupancy may be made to establish any occupancy classification provided the building is not substantially altered.
2. In buildings constructed prior to October 6, 1933, a change may be made from one occupancy to another of a lesser hazard as listed in the following table and, except for the assembly buildings, hospitals and schools, a change may be made to another occupancy within the same hazard groups. A change to a higher hazard occupancy, or assembly buildings, hospitals and schools occupancy, shall not be made in buildings constructed prior to October 6, 1933, except for Type I (or Class A) buildings as provided for in Item 3.
    1. Private garages, carports (least hazardous).
    2. One and two family dwellings.
    3. Gas stations and parking garages.
    4. Businesses, factories, restaurants (less than 50 occupants) and hazardous materials occupancies.
    5. Hotels and apartments.
    6. Assembly buildings, hospitals and schools (most hazardous).
3. In Type I (or Class A) buildings constructed prior to October 6, 1933, a change to a higher hazard classification (as listed in Item 2) or to an assembly, hospital or school occupancy will be individually considered taking into account the general structural requirements in effect at the time the building was constructed, the structural system used in the building, the condition classification, the occupant load and other pertinent conditions.

For the purpose of this Rule, the Occupancy classification of interconnected assembly rooms shall be based upon the total of all occupants in such rooms. The provisions of this Rule shall not be presumed to waive the requirements of Section 91.0315(a) which provides that any assembly, hospital or school occupancy, housed in buildings constructed prior to 1934, which have been discontinued for a period of more than six months, must comply with all code requirements prior to being reoccupied.

Increases in Occupancy Load (Without a Change of Occupancy)

Increases in occupant load, within existing floor space, that do not cause a change in occupancy may be made to any occupancy in any building without

verifying that the building complies with current structural requirements of the Building Code except where Section 91.0315(b) applies. Section 91.0315(b) prohibits an increase in occupant load in assembly occupancies located in buildings constructed prior to 1934 unless the entire building conforms to the current structural design provisions of the Building Code.

This Rule supersedes RGA 657 adopted by the Superintendent of Building and effective on December 29, 1965.

The foregoing Rule of General Application shall become effective upon publication.

0351 A-P5,6/0005A

February 6, 1979, Rev. 1

NOTE: Appendix 9 has been editorially revised to refer to occupancies by definition rather than to utilize occupancy letter designations used in the Los Angeles Building Code.

APPENDIX 10

State of California Seismic Safety Commission
Draft Legislation Relating to Seismic Hazards

DRAFT LEGISLATION RELATED TO HAZARDOUS BUILDINGS FOR SUBMISSION IN THE 1979-80 REGULAR SESSION

LEGISLATIVE COUNSEL'S DIGEST

(1) Existing law authorizes a city, city and county, or county to establish construction standards for any building, except specified unoccupied buildings, rural one and two family dwellings, farm buildings, buildings under construction on and prior to May 26, 1933, and other described rural buildings,constructed in this state to meet lateral forces acting upon the building, as specified in regulations adopted by the Department of Housing and Community Development, and authorizes a city, city and county,or county to adopt construction standards more strict than such specified standards for earthquake protection. Such provisions apply when buildings are constructed or altered after adoption of the standards.

This bill would authorize a city, city and county, or county to establish construction standards for reconstruction of existing buildings determined, as specified, to be a hazard to life in the event of an earthquake, which standards are as specified in the bill and would eliminate the problem of complying with the latest building code governing new construction when rehabilitating older buildings. The bills would authorize the city, city and county, or county to adopt higher standards than as provided in the bill. However, the bill would prohibit a building from being declared a seismic hazard to life after reconstruction pursuant to a later adopted ordinance unless the building no longer meets the seismic hazard standards under which it was reconstructed.

The bill would also require the Seismic Safety Commission to recommend changes to such provisions of the bill by June 30, 1985.

(2) This bill would provide that there is no appropriation made for the reimbursement to local agencies for costs incurred by them by this bill pursuant to Section 2231 of the Revenue and Taxation Code for a specified reason.

SEC. I. Article _____ (commencing with Section _____ is added to Chapter _____ of Part _____ of Division _____ of the Health and Safety Code, to read:

Article _____. Earthquake Hazardous Building Reconstruction

_____. The Legislature finds and declares that:

(a) Because of the generally acknowledged fact that California will experience moderate to great earthquakes in the foreseeable future, increased efforts to reduce earthquake hazards should be encouraged and supported.

(b) Tens of thousands of buildings subject to severe earthquake hazards continue to be a serious danger to the life and safety of hundreds of thousands of Californians who live and work in them in the event of an earthquake.

(c) Improvement of safety to life is the primary goal of building reconstruction to reduce earthquake hazards.

(d) A building may be hazardous to life in the event of an earthquake, if the building was constructed prior to the adoption and enforcement of local building codes requiring earthquake resistant design of buildings; is constructed of unreinforced bearing wall masonry construction on the effective date of this Article, and exhibits any one of the following characteristics:

(1) exterior parapets or ornamentation that may fall on a public way,

(2) exterior walls that are not anchored to the floors or roof,

(3) lacks an effective system to resist seismic forces.

(e) In order to make building reconstruction economically feasible and to provide improvement of the safety or life in seismically hazardous buildings, standards enacted by local government for building reconstruction will differ from standards which govern new building construction.

_____. Each city, city and county, or county may assess the earthquake hazard in its jurisdiction and establish by ordinance, it is deems appropriate, seismically hazardous building reconstruction standards commensurate with the magnitude of the local earthquake hazard.

_____. Notwithstanding the provisions of Sections 19100 or 19150 of the Health and Safety Code or any other provision of law, excepting those structures or buildings which are needed for emergency purposes after an earthquake in order to preserve the peace, health and safety of the general public, such as hospitals and other medical facilities having surgery or emergency treatment areas, fire and police stations; municipal government disaster operation centers and public utility and communication buildings deemed vital in emergencies, the governing body of any city, city and county, or county may, by ordinance, establish standards for reconstruction of buildings identified by the city, city and county, or county as being hazardous to life in the event of an earthquake. Such seismic building reconstruction standards may be applied uniformly throughout the city, city and county, or county or may be applied in specific areas designated by the city, city and county, or county. The identification of any buidling as being potentially hazardous to life in the event of an earthquake shall be made by a licensed or certified architect or registered civil or structural engineer as defined by Chapter 3 or Chapter 7 of the Business and Professions Code.

_____. Any local ordinance adopted pursuant to Section _____ shall require that:

(a) The reconstructin of any building identified as being hazardous

to life in the event of an earthquake shall provide for the reasonable adequacy of:

(1) Unreinforced masonry walls to resist normal and inplane seismic forces,

(2) The anchorage and stability of exterior parapets and ornamentation,

(3) The anchorage of unreinforced masonry walls to the floors and roof,

(4) Floor and roof diaphragms,

(5) The development of a complete bracing system to resist earthquake forces.

(b) Any building or portions of any building reconstructed pursuant to the ordinance shall resist and withstand seismic forces from any direction of a magnitude not less than the seismic forces set forth in the local ordinance. The magnitude of the seismic forces and allowable working stresses shall be established after review and consideration of model ordinances prepared by the Seismic Safety Commission.

(c) Any city, city and county, or county may assign allowable working stresses to existing materials based on substantiating research data. In the event the local jurisdiction does not have the ability to assign such allowable working stresses, it can use those prepared by _____ by the Office of State Architect, subject to approval by the Seismic Safety Commission.

_____. Any city or county adopting an ordinance establishing standards for reconstruction of buildings identified as being hazardous to life, in the event of an earthquake shall file with the Seismic Safety Commission a copy of the ordinance and all subsequent amendments.

_____. Any building identified as being a seismic hazard to life and reconstructed in compliance with a local ordinance adopted pursuant to this article may not within a period of fifteen years be identified as a seismic hazard to life pursuant to any local ordinance adopted after the date of the building reconstruction unless such building no longer meets the seismic hazard standards under which it was reconstructed.

_____. The Seismic Safety Commission shall review and assess the effectiveness of State regulations and local government ordinances adopted pursuant to this article and shall recommend any necessary changes to the Legislature by June 30, 1985, or earlier at its discretion.

SEC. 2. Notwithstanding Section 2231 of the Revenue and Taxation Code, there shall be no reimbursement pursuant to that section nor shall there be an appropriation made by this act because the duties, obligations, or responsibilities imposed on local govenment by this act are such that related costs are incurred as part of their normal operating procedures.

APPENDIX 11

Chapter 10, Official Electrical Code of the City of Detroit

CHAPTER 10 OF THE CODE IS ADDED AS FOLLOWS:

1000-1. MINIMUM STANDARDS FOR EXISTING DWELLING UNITS

IF INSPECTION REVEALS THAT THE WIRING SYSTEM OF AN EXISTING DWELLING TYPE OCCUPANCY IS INADEQUATE, OR IF CODE CERTIFICATION AS A HABITABLE DWELLING UNDER THIS SECTION IS REQUESTED, THE FOLLOWING MINIMUM REQUIREMENTS SHALL BE COMPLIED WITH:

(a) **ENTRANCES AND EXITS:** WHERE TWO (2) OR MORE ENTRANCES AND/OR EXITS EXIST, AT LEAST TWO (2) ENTRANCES AND/OR EXITS SHALL BE ILLUMINATED BY EXTERIOR LIGHTS. LIGHTING OUTLETS SHALL BE CONTROLLED BY INTERIOR WALL SWITCHES, LOCATED FOR CONVENIENT AND READILY ACCESSIBLE USE.

(b) **LIVING ROOM:** LIVING ROOM SHALL BE PROVIDED WITH ILLUMINATION. LIGHTING OUTLET SHALL BE CONTROLLED BY A WALL SWITCH, LOCATED FOR CONVENIENT AND READILY ACCESSIBLE USE. ONE OF THE RECEPTACLE OUTLETS CONTROLLED BY A WALL SWITCH IN LIEU OF CEILING LIGHTING OUTLET IS ACCEPTABLE. CONVENIENT DUPLEX RECEPTACLE OUTLETS SHALL BE PROVIDED. RECEPTACLE OUTLETS SHALL BE EQUALLY SPACED AROUND THE ROOM WITH AT LEAST ONE DUPLEX RECEPTACLE OUTLET ON EACH WALL.

(c) **KITCHEN:** KITCHEN SHALL BE PROVIDED WITH ILLUMINATION. LIGHTING OUTLET SHALL BE CONTROLLED BY A WALL SWITCH LOCATED FOR CONVENIENT AND READILY ACCESSIBLE USE.

A SEPARATE KITCHEN APPLIANCE CIRCUIT SHALL BE PROVIDED SUPPLYING A MINIMUM OF THREE (3) GROUNDING TYPE DUPLEX RECEPTACLE OUTLETS. TWO (2) OF THESE RECEPTACLES SHALL BE READILY ACCESSIBLE FOR CONVENIENT USE OF PORTABLE APPLIANCES. NEW APPLIANCE CIRCUITS SHALL BE TWENTY AMPERE CAPACITY.

(d) **BATHROOM:** BATHROOMS SHALL BE ILLUMINATED. LIGHTING OUTLET SHALL BE CONTROLLED BY A WALL SWITCH. A RECEPTACLE OUTLET SEPARATE FROM THE LIGHT FIXTURES, SHALL BE PROVIDED AND SHALL BE LOCATED AT LEAST THIRTY (30) AND NOT MORE THAN FORTY-EIGHT (48) INCHES ABOVE THE FLOOR ADJACENT TO THE WASH BASIN AND NOT MORE THAN FOUR (4) FEET FROM THE BASIN.

(e) **ALL OTHER HABITABLE ROOMS:** ILLUMINATION FOR EACH HABITABLE ROOM SHALL BE PROVIDED. LIGHTING OUTLET SHALL BE CONTROLLED BY A WALL SWITCH. WALL SWITCHES SHALL BE LOCATED FOR CONVENIENT AND READILY ACCESSIBLE USE. CONVENIENCE DUPLEX RECEPTACLE OUTLETS SHALL BE PROVIDED WITH A MINIMUM OF TWO (2) RECEPTACLE OUTLETS EQUALLY SPACED AROUND THE ROOM. AN ADDITIONAL RECEPTACLE OUTLET CONTROLLED BY A WALL SWITCH IS ACCEPTABLE IN LIEU OF A LIGHTING OUTLET.

(f) **BASEMENT:** BASEMENT SHALL BE WIRED FOR A MINIMUM OF ONE LIGHTING OUTLET IN EACH 200 SQUARE FEET OR MAJOR FRACTION OF AREA FOR USE AS GENERAL ILLUMINATION. ALL ENCLOSED AREAS THAT MAY BE WALKED INTO SUCH AS TOILET ROOMS, FRUIT STORAGE ROOMS, UTILITY ROOMS, EXCAVATED AREAS UNDER PORCHES, ETC., SHALL BE PROVIDED WITH AT LEAST ONE LIGHTING OUTLET (EXCEPT COAL BINS).

STAIRWELL AND LAUNDRY AREA LIGHTING OUTLETS SHALL NOT BE COUNTED AS PART OF THE REQUIRED BASEMENT LIGHTING OUTLETS.

(g) **LAUNDRY AREAS:** LAUNDRY AREAS SHALL BE PROVIDED WITH ILLUMINATION. LAUNDRY CIRCUIT SHALL BE AN INDIVIDUAL CIRCUIT. A WALL-MOUNTED GROUNDING TYPE DUPLEX RECEPTACLE OUTLET SHALL BE PROVIDED, LOCATED NEAR THE LAUNDRY EQUIPMENT.

AN EXISTING DROP CORD RECEPTACLE OUTLET ON A SEPARATE CIRCUIT SHALL BE ACCEPTABLE PROVIDING IT IS A GROUNDING TYPE RECEPTACLE OUTLET NOT MORE THAN FIVE (5) FEET SIX (6) INCHES ABOVE THE FLOOR.

(h) **SPACE HEATING SYSTEM:** HEATING EQUIPMENT REQUIRING ELECTRICAL ENERGY FOR OPERATION AND/OR CONTROL SHALL BE PROVIDED WITH AN INDIVIDUAL CIRCUIT. A DISCONNECT SWITCH SHALL BE PROVIDED ON OR ADJACENT TO THE HEATING EQUIPMENT. (EXCEPTION: THERMO-PILE CONTROLLED FURNACES).

(i) **STAIRWELLS:** STAIRWELLS SHALL BE ADEQUATELY ILLUMINATED. LIGHTING OUTLETS SHALL BE CONTROLLED BY WALL SWITCHES. WALL SWITCHES SHALL BE LOCATED FOR CONVENIENT AND READILY ACCESSIBLE USE. SWITCHES SHALL NOT BE LOCATED WHERE IT IS NECESSARY TO USE DARKENED STAIR SECTIONS FOR THEIR OPERATION. ALL STAIRWELLS TO FINISHED PORTIONS OF DWELLING SHALL BE PROVIDED WITH MULTIPLE SWITCH CONTROL, ONE AT THE HEAD, THE OTHER AT THE FOOT OF THE STAIRWELL.

(j) **SERVICE AND/OR FEEDER:** SERVICE TO EXISTING DWELLING UNIT SHALL BE A MINIMUM OF ONE HUNDRED AMPERE, THREE WIRE CAPACITY. SERVICE EQUIPMENT SHALL BE DEAD FRONT HAVING NO LIVE PARTS EXPOSED WHEREBY ACCIDENTAL CONTACT COULD BE MADE. TYPE "S" FUSES SHALL BE INSTALLED WHEN FUSED EQUIPMENT IS USED.

EXCEPTION: EXISTING SERVICE OF FIFTY-FIVE AMPERE THREE WIRE CAPACITY, AND FEEDERS OF THIRTY AMPERE OR LARGER TWO OR THREE WIRE CAPACITY SHALL BE ACCEPTED IF ADEQUATE FOR THE ELECTRICAL LOAD BEING SERVED.

(k) **EXISTING WIRING AND EQUIPMENT:** EXISTING WIRING AND EQUIPMENT SHALL BE IN GOOD REPAIR. CIRCUIT EXTENSIONS MADE WITH FLEXIBLE CORD WIRING IN LIEU OF PERMANENT WIRING SHALL BE ELIMINATED.

1000-2. **NEW WORK:** ALL NEW WORK SHALL CONFORM TO THIS ORDINANCE.

1000-3. **EVIDENCE OF INADEQUACY.** EVIDENCE OF INADEQUACY SHALL BE ANY OF THE FOLLOWING:

(a) USE OF CORDS IN LIEU OF PERMANENT WIRING.

(b) OVERSIZING OF OVERCURRENT PROTECTION FOR CIRCUITS, FEEDERS OR SERVICE.

(c) ILLEGAL EXTENSIONS TO THE WIRING SYSTEM IN ORDER TO PROVIDE LIGHT, HEAT OR POWER.

(d) ELECTRICAL OVERLOAD.

(e) MISUSE OF ELECTRICAL EQUIPMENT.

(f) LACK OF LIGHTING FIXTURES IN BATHROOM, LAUNDRY ROOM, FURNACE ROOM, STAIRWAY OR BASEMENT.

APPENDIX 12

Format and Methodology for
Developing a Local Rehabilitation
Code, Regulations, or Guidelines

The approach presented here deals with the safety and health objectives of building regulation, since it is assumed that accepting reduced levels of performance related to these two areas will be more difficult to justify than similar reductions related to welfare or to property protection. However, similar approaches can be developed for analysis related to these goals also.

When considering the rehabilitation of a given existing building, it is necessary to analyze its intended use and occupancy, in order to determine what levels of performance should be required by the regulation. It is useful to consider separately three categories of attributes for which performance is regulated by codes:

- Structural safety
- Fire safety
- Accident safety, health and hygiene

In the suggested analytical approach, the proposed use of building is analyzed by considering a series of matrices. Each matrix requires the consideration of a set of code regulated attributes with respect to each occupancy group. For purposes of illustration, the CABO/BCMC occupancy index is used. However, a community applying this approach should substitute the occupancy classifications in its building code. The occupancy designations and a brief description are as follows:

Group A - Assembly occupancy is the use of a building or structure, or any portion thereof, for the gathering together of persons for purposes such as civic, social or religious functions or for recreation, or for food or drink consumption or awaiting transportation.

Group B - Business Occupancy is the use of a building or structure, or any portion thereof, for office, professional, or service type transactions including normal accessory storage and the keeping of records and accounts.

Group E - Educational Occupancy is the use of a building or structure, or any portion thereof, for the gathering together of persons for the purpose of instruction.

Group H - Hazardous Occupancy is the principal use of a building or structure, or any portion thereof, that involves highly combustible materials or flammable materials or explosive materials that have inherent characteristics that constitute a higher fire hazard.

Group F - Factory-Industrial Occupancy is use of a building or structure, or any portion thereof, for assembling, disassembling, repairing, fabricating, finishing, manufacturing, packaging or processing operations that are not otherwise classified in this code.

Group I - Institutional Occupancy is use of a buildng or structure, or any portion thereof, for the purpose of providing medical treatment or care and sleeping facilities of persons who are mostly incapable of self-preservation because of age, physical or mental disability, or because of security measures not under the occupants' control.

Group M - Mercantile Occupancy is the use of a building or structure, or any portion thereof, for the display and sale of merchandise.

Group R - Residential Occupancy is the use of a building or structure, or any portion thereof, for sleeping accommodations and is not classed as an Institutional Occupancy.

Group S - Storage Occupancy is the principal use of a building or structure, or any portion thereof, for storage that is not classed as a Hazardous Occupancy or for the purpose of sheltering animals.

A more detailed occupancy description is included in the model codes.

(a) Structural Safety

A community might find it useful to carry out the analysis by considering in detail a matrix which addresses each of the building code's occupancy groups, and three attributes of structural safety.

	VERTICAL LIVE & DEAD LOADS	SEISMIC LOADS	WIND LOADS
A - Assembly			
B - Business			
E - Educational			
F - Factory			
I - Institutional			
M - Mercantile			
R - Residential			
S - Storage			

- Vertical Live and Dead Loads

It is unlikely that lower levels of performance may be acceptable here. If the proposed occupancy results in increased vertical live or dead loading, the building must be capable of supporting this loading utilizing design stresses permitted in the current building code. Where the building is constructed with archaic materials, appropriate research source data should be used in context with the historical experience of that type of construction material. Factors of safety required for archaic materials should be comparable to those required by the current building code. In the event it is not possible to establish allowable design stresses for a design analysis, it may be necessary that load tests be conducted. The amount of load to be applied varies depending upon the materials utilized since all materials do not perform in an identical manner. Higher factors of safety are sometimes applied to concrete, masonry and wood construction than are applied to other materials due to their inherent natural variability. Most codes and a variety of national standards prescribe load test procedures.

- Seismic Loads

Buildings built to comply with earlier editions of building code are likely not to have been designed for the magnitude of seismic forces required by the current building code.

Appendices 9 and 10 contain two specific examples of regulations establishing reduced requirements for seismic design in rehabilitated buildings when compared to new construction requirements. A community must carefully analyze its building stock in relation to its seismic risk. It must determine if the proposed occupancy results in an increase to "life risk", from a structural viewpoint, in the event of building failure. As a general premise, one could assume that if the proposed use contains a greater number of occupants it would increase the "life risk" in the event a building collapsed during an earthquake. A further consideration would be the number of hours a day or days per week that the building is occupied, considering the probability of an earthquake occurring when the building is occupied. Also, such an analysis may consider the relative importance of particular buildings or classes of buildings to the community (e.g., hospitals, power stations, fire stations, etc.).

The "Tentative Provisions for Development of Seismic Regulations for Buildings (ATC 3-06)" contains a chapter on Systematic Abatement of Seismic Hazards in Existing Buildings. Following procedures of this type may be desirable for buildings being rehabilitated or undergoing occupancy changes in high seismic risk areas.

- Wind Loads

Wind forces must be considered as well as seismic forces when buildings undergo rehabilitation or a change in occupancy or use. Seismic forces may be more critical, however, since earthquakes cannot be predicted and occupants are unable to evacuate the structure when an earthquake occurs. Occupants of structures located in areas subject to strong wind forces such as tornados or hurricanes are generally warned well in advance of the event and can go to areas of refuge.

Additionally, if a building has been in existence for a number of years, it has probably been subjected to the maximum expected wind force for the area, except in specific hurricane areas. Accordingly, one could reasonably assume that wind design would not be a major consideration for buildings undergoing rehabilitation or a change of occupancy, and a reduction of the level of performance required for building rehabilitation compared to that for new construction, for most occupancies, may be more acceptable and easier to justify.

(b) Fire Safety

Codes provide for life safety in buildings by regulating various fire safety features associated with the buildings' intended use. The basic premise is to assure that all occupants in all occupancies are provided with an equivalent level of life safety. These regulations are based on various considerations including ignition hazards, fuel loading, occupant density, panic, sleeping, etc. For new construction these regulations are set down in a straight forward manner in all building codes. However, when an existing building is being rehabilitated or changed from one occupancy to another, the issue is more complex.

If a community wishes to explore the possibility of modifying or waiving new construction fire safety requirements for buildings being rehabilitated or undergoing a change of occupancy, while maintaining a reduced but acceptable level of safety, it must evaluate the fire safety features of existing buildings relative to the hazard of the proposed new occupancy. In some cases, the interaction of fire safety features and hazards between existing

buildings and proposed use will be acceptable. In other cases, the interaction may even make the building unsuitable for conversion to the new use.

A methodology should be developed for analyzing particular existing buildings for specific proposed occupancies. Such a methodology may consider various fire-related hazards, such as:

(1) Ignition Hazards: The hazard due to open flame, heating, cooking or electrical equipment.

(2) Smoldering Fires: The hazard of fire developing undetected.

(3) Spread of Fire: The hazard of fire spreading in the building once ignited. This is controlled by limitations on flame spread on finish materials, especially in exitways and corridors. Also by amount of combustibles in the building assembly.

(4) Spread of Smoke: Smoke is the primary life hazard. It spreads through unenclosed stairways and vertical shafts, open doors, ducts, etc. It may cause panic.

(5) Panic: The hazard relates to building occupants' behavior, and partly depends on familiarity with the building, number of occupants, etc.

(6) Exiting: The means of exiting from or within the building to a place of refuge within a given time period. Hazard is controlled by limitations on deadend corridors, enclosure of stairways, doors and closures, and similar means.

(7) Community Safety: The hazard of fire spreading to adjacent buildings. Prevention of fire spread between any two buildings is dependent on the buildings' spatial relationship, type of construction, roof covering, wall protection and reasonable expectations of the capability of the fire suppression services.

A matrix relating such hazards to occupancy groups may be useful in the analysis.

PROPOSED OCCUPANCY	HAZARD						
	(1) Ignition	(2) Smoldering fires	(3) Spread of fire	(4) Spread of Smoke	(5) Panic	(6) Exiting	(7) Community Safety
A - Assembly							
B - Business							
E - Educational							
F - Factory							
I - Institutional							
M - Mercantile							
R - Residential							
S - Storage							

A community may rank order the hazards for each occupancy category based on knowledge of the building stock, local fire history and local firefighting capabilities. Such a rank ordering, reflecting specific community characteristics, can then be used to identify those building code requirements which may be modified or alleviated in the case of rehabilitation or change of occupancy, without incurring an unacceptable level of risk.

(c) Accident Safety, Health and Hygiene

Accident safety, health and hygiene are each regulated by a variety of building code provisions. Current regulations require that buildings should be brought to a condition of safety commensurate with that required for new buildings, when undergoing extensive rehabilitation or change of occupancy. A community may analyze its particular situation to determine specific areas where less than full compliance with new construction requirements would be acceptable in rehabilitated buildings, without incurring an unacceptable level of safety.

A similar analysis to that recommended for fire safety may benefit from a similar matrix.

ENVRIONMENTAL REQUIREMENTS	Assembly	Business	Educational	Factory/industrial	High hazard	Institutional	Mercantile	Residential, hotel	Residential, multifamily	Residential, 1 & 2 family	Storage
• PREMISES CONDITION											
Rubbish, weeds											
Grading and drainage, ponding											
Insect and rodent control											
Paved areas repair											
Exhaust vent discharge											
• EXTERIOR STRUCTURE											
Weatherproof roof											
Weatherproff walls											
Weathertight and operable openings (doors and windows											
Glazing											
• INTERIOR STRUCTURE											
Lead-based paint											
Bathroom and kitchen floors											
Treads and risers - uniform dimensions											
Obstruction in egress - headroom and width											
Handrails, guardrails											
Walls and ceilings - structurally stable											
Floor surfaces - uneven, obstacles											

LIGHT, VENTILATION, AND SPACE REQUIREMENTS	Assembly	Business	Educational	Factory/industrial	High hazard	Institutional	Mercantile	Residential, hotel	Residential, multifamily	Residential, 1 & 2 family	Storage
o LIGHT											
Window area, no artificial											
Halls and stairways											
Other spaces											
o VENTILATION											
Window area											
Toilet rooms, window or mechanical											
Cooking facilities											
Mechanical ventilation, if not natural											
o DWELLING UNITS											
Privacy											
Common access											
Basement rooms											
o SPACE											
Floor area											
Ceiling heights											
Acoustics											
PLUMBING FACILITIES											
o REQUIRED FACILITIES											
Dwelling unit water closet & lav											
Accessibility, adequate fixtures											

	Assembly	Business	Educational	Factory/industrial	High hazard	Institutional	Mercantile	Residential, hotel	Residential, multifamily	Residential, 1 & 2 family	Storage
• TOILET ROOMS											
Privacy											
Accessibility											
Floor, partition, wall materials											
• FIXTURES											
Quality											
Connections											
Operation and functional adequacy											
• WATER SUPPLY											
Hot and cold											
Contamination											
Water heater											
• SEWAGE SYSTEM											
Sewer functionally adequate											

Volume 2
Rehabilitation Guidelines

TECHNICAL GUIDELINES FOR RESIDENTIAL REHABILITATION

FOREWORD

Section 903 of the Housing and Community Development Amendments of 1978 (Public Law 95-557, enacted October 31, 1978) requires that the Secretary of the Department of Housing and Urban Development:

> *"develop model rehabilitation guidelines for the voluntary adoption by States and communities to be used in conjunction with existing building codes by State and local officials in the inspection and approval of rehabilitated properties."*

Section 903 of the Amendments was predicated in part by the March 24, 1978 hearing on the "Impact of Building Codes on Housing Rehabilitation," held by the Senate Committee on Banking, Housing, and Urban Affairs. The hearing highlighted the many code-related problems that arise during the rehabilitation of the nation's existing building stock. Hearing testimony indicated that a significant cause of these problems was that existing codes and code enforcement techniques are primarily designed for new construction, and contain neither the administrative, legal, or technical mechanisms to properly deal with rehabilitation. This has led to:

- increased rehabilitation costs
- discouragement of otherwise feasible rehabilitation projects
- time delays due to lengthy municipal approval requirements
- encouragement of illegal activities by persons seeking to avoid unreasonable code requirements

Section 903 of the Amendments also requires that the Secretary of the Department of Housing and Urban Development shall:

> *"publish such guidelines for public comment not later than one year after the enactment of this section, and promulgate them no later than eighteen months after such date of enactment."*

Accordingly, the following draft documents have been prepared for public comment:

Rehabilitation Guidelines, Volume 1
Administrative and Legal Guidelines for Building Rehabilitation

Rehabilitation Guidelines, Volume 2
Technical Guidelines for Residential Rehabilitation

Rehabilitation Guidelines, Volume 3
Guideline on Fire Ratings of Archaic Materials and Assemblies

The intent of these guidelines is to reduce, while maintaining essential levels of health and safety, those regulatory requirements that create unnecessary constraints, time delays, and higher costs for building rehabilitation.

Volume 1, Administrative and Legal Guidelines for Building Rehabilitation, is designed for use by building officials, members of the legislative and executive branches of State and local governments, and related commissions and organizations that are involved in developing or implementing building regulations. Volume 1 covers the following topics:

- The Guideline for Setting and Adopting Standards for Building Rehabilitation provides an introduction and background to the building regulations that affect rehabilitation. It shows methods for identifying existing regulatory conditions in a community and lists recommendations for amending or modifying the community's regulatory system to encourage rehabilitation.
- The Guideline for Municipal Approval of Building Rehabilitation outlines a model submittal, review, and approval process for rehabilitation that is recommended for adoption by municipal building departments.
- The Statutory Guideline for Building Rehabilitation provides recommendations for statutorily modifying existing code decision making systems with the express goal of promoting rehabilitation.
- The Guideline for Managing Official Liability Associated with Building Rehabilitation addresses the liability of code officials involved with the regulation and enforcement of building rehabilitation, and provides recommendations for minimizing liability problems.

Volume 2, Technical Guidelines for Residential Rehabilitation, is intended for use by code inspectors, designers, and builders involved in residential rehabilitation. Volume 2 covers the following topics:

- The Egress Guideline for Residential Rehabilitation lists design alternatives for the components of egress that are regulated by current codes: number of exits, corridors and stairs, arrangement of exits, travel distance, dead-end travel, and exit capacity and width.
- The Electrical Guideline for Residential Rehabilitation discusses the establishment of standards for electrical rehabilitation, gives procedures for conducting inspections of electrical systems, and presents problems and solutions associated with electrical rehabilitation.
- The Plumbing DWV Guideline for Residential Rehabilitation includes a background discussion of basic drainage and hydraulic concepts, followed by criteria to determine the condition and capacity of existing DWV (drainage, waste, and vent) systems. Methods and criteria are presented for relocating fixtures, adding new fixtures to existing DWV systems, extending existing DWV systems, and installing new DWV systems in existing buildings. Through-the-wall venting is also discussed.

Volume 3, Fire Ratings of Archaic Materials and Assemblies, is intended for use by code officials and designers in determining the fire ratings of building materials and assemblies that are no longer listed in current building codes or related reference standards. Extensive entries are provided for the fire ratings of walls, columns, floors and ceilings. Introductory material discusses flame spread, the effects of penetrations, and methods for determining the ratings of assemblies not listed in the guideline.

The draft rehabilitation guidelines were prepared by the National Institute of Building Sciences under contract to the Department of Housing and Urban Development. Issues addressed in the guidelines were selected from a March, 1978 study by the Institute entitled "Code-Related Rehabilitation Problems: Problem Identification/Verification/Feasibility Report," which identified approximately fifty code-related problems and determined that eighteen of these problems were feasible to address within the state-of-the-arts and within the legislated time constraints. Actual problem selection was made by a committee formed by the Institute under the legislative mandate that:

> *"such guidelines shall be developed in consultation with.....appropriate national organizations of agencies and officials of State and local governments, representatives of the building industry, and consumer groups, and other interested parties."*

The committee formed by the Institute was composed of representatives of the following organizations:

- Council of American Building Officials
- National Conference of States on Building Codes and Standards
- National Fire Protection Association
- American Institute of Architects
- Building Code Action
- National Home Improvement Council
- National Housing Rehabilitation Association
- National Association of Home Builders
- AFL-CIO Building and Construction Trades Department
- Association of Major City Building Officials
- U.S. Conference of Mayors
- National League of Cities
- National Trust for Historic Preservation
- U.S. League of Savings Associations
- National Association of Housing and Redevelopment Officials

Major subcontractors used by the Institute for addressing the selected problems included:

- Building Technology, Inc.
- Joseph Stein
- Davidson Laboratory, Stevens Institute of Technology
- Council of American Building Officials
- J. Bradford Corporation
- National Fire Protection Association
- Arthur D. Little, Inc.
- National Conference of States on Building Codes and Standards
- Vincent Brannigan, Esq.

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CHAPTER 1

EGRESS GUIDELINE

FOR

RESIDENTIAL REHABILITATION

INTRODUCTION

Egress requirements create a great number of technical problems and constraints in building rehabilitation. Existing exits which appear to be adequate will often not comply with the highly specific requirements for new building construction. Code requirements should be strictly followed whenever possible. But where literal compliance proves impractical, flexibility is essential.

The 1976 Edition of the Life Safety Code states as a purpose "to avoid requirements which might involve unreasonable hardships or unnecessary inconvenience or interference with the normal use and occupancy of a building" while insisting upon "compliance with a minimum standard for fire safety necessary in the public interest." The guidelines embrace this purpose by encouraging and suggesting design solutions that will meet the intent, though not necessarily the specifics, of the respective codes.

A safe means of escape from fire is fundamental to fire protection. But it is not the only way to provide life safety from fire, and it is not always the most practical: fire officials would need hours to evacuate New York's World Trade Center. Different building types will often pose different egress problems. The code requirements for egress must be responsive to the qualities and needs of the people to be protected and the hazards that they face. The guidelines developed below apply to residential uses: one and two family dwellings, townhouses, condominimums and apartment buildings less than 75 feet in height.

The differing requirements of the three model building codes (Basic, Standard, Uniform) and the Life Safety Code illustrate that there is no single correct solution. The codes reflect the differences in opinion and philosophy that exist whenever professional judgement must be exercised. The issue is not which approach is most correct, but which is most appropriate once the character of the building and the occupants is known.

Given that a fire ignition has occurred, there are two basic approaches to solving the life safety problem: 1) protect the people; 2) control the fire. The people could either be evacuated from the building or protected in place until the fire is extinguished and the danger passes. The fire can be controlled by suppression (e.g., automatic sprinklers) or compartmentation (e.g., fire rated construction, protection of horizontal/vertical openings).

Smoke control systems prevent smoke and other fire gases from spreading throughout a burning building. Exits free of smoke can be used more safely and efficiently; the protection of

occupants becomes more feasible because life-threatening combustion products are removed from the building. No specific recommendations have been made concerning the use of smoke control systems, but the potential of the rapidly improving technology must be recognized.

In residential buildings, the simplest and most direct solution is to evacuate the occupants. This may avoid the need to upgrade the fire resistance of major structural elements such as walls, floor/ceiling assemblies, and doors. Such major structural renovation is counter to the goal of decreasing the cost and complexity of building rehabilitation, particularly when alternatives are usually available. However, the approaches mentioned above are interrelated such that a single fire protection measure may have more than one impact. For example, a suppression system can potentially control the fire, provide an emergency alarm to the occupants and possibly the fire department, and increase the time for safe escape by earlier detection of the fire and protection of the egress path.

The evacuation system consists of three interrelated component parts, and the guidelines build upon these relationships. The components are: fire detection and alarm; a path of escape or means of egress; and a safe destination. In a one and two family dwelling "fire detection and alarm" is a smoke detector; the "means of egress" is the front door; the "safe destination" is the outside or some other protected area of refuge.

The concepts are equally applicable to apartment buildings, though the problems and requirements are more complex. Fire detection and alarm is more difficult because a smoke detector will only warn the occupants in a single unit, not the entire building. Two or more exits, instead of a single exit, are generally required. But once the weaknesses of the egress system are understood, the guidelines can help identify practical solutions. For example, fire detection and suppression systems can provide added time to escape through earlier detection or fire control. Improved lighting or handrails might compensate for irregular stairs when the number of occupants is small and the people are physically able.

The examples cited and the egress guidelines that have been developed are not exhaustive. Each building will present special problems that will require special treatment. Once the intent of the code requirement and the impact of the deficiency are understood, it may be possible to fashion an alternative solution. But the most important consideration will always be the nature of the occupants and the use and arrangement of the building.

The assumptions underlying all the egress guidelines are that the number of occupants will be small, they will be familiar with their surroundings, they will react quickly and properly to an alarm of danger, and that they are physically and mentally capable of using whatever means of escape are provided. Special care must be taken should any of these assumptions not apply.

ARRANGEMENT OF THE GUIDELINE

The egress guidelines have been arranged as follows:

The occupant load (see next section), the physical characteristics of the building (e.g., height, area) and the use (e.g., apartment) determine the minimum number of exits that are required. Guideline A: NUMBER OF EXITS addresses this area.

Once the minimum number of exits is known, the number of available exits is counted. The concern is that the exits are of the proper type and that minimum fire separation requirements, if any, are met. For example, some codes place limits on the use or number of horizontal exits. Most codes require stairs to be protected by fire-rated construction. Guidelines have not been developed for every acceptable egress component, but Guidelines B.1-B.4: HORIZONTAL EXITS; INTERIOR STAIRS/ENCLOSURES; EXTERIOR EXIT STAIRS; FIRE ESCAPE STAIRS apply here.

The location and layout of the qualifying exits is then examined. See Guideline C: ARRANGEMENT OF EXITS. Improper arrangement may require that additional exits be provided.

Access to these exits must also be evaluated and corrective measures must be taken as needed. Guideline D: TRAVEL DISTANCE; Guideline E: DEAD-END TRAVEL; and Guideline F: CORRIDORS AND EXTERIOR EXIT BALCONIES should be applied at this time.

Once the number of required exits has been provided and their arrangement and access is satisfactory, the capacity of the exits and minimum width dimensions must be considered. Guideline G: EXIT CAPACITY/WIDTHS applies here.

Finally, the specific construction details of the egress components must be evaluated. See Guideline H: CONSTRUCTION DETAILS AND SPECIFICATIONS.

Within each of these eight (A-H) Guidelines, there is a 3-part discussion. First, there is a summary of code requirements and intent, including a discussion of the respective requirement in the Basic, Standard, Uniform and Life Safety Codes. Second, there is a discussion of how to identify conditions in the building, to determine whether a problem exists. Third, there is a discussion of the problem, its solution(s) and a general narrative relating the two.

References to the applicable sections of the model codes have been included throughout the Guideline. The references are as follows:

BOCA	Basic Building Code (1978 Edition)
NFPA	NFPA Life Safety Code (1976 Edition)
SBCC	Standard Building Code (1979 Edition)
UBC	Uniform Building Code (1979 Edition)

OCCUPANT LOAD

The occupant load is the number of people that can be expected to be present in the building. The occupant load is used to calculate the number of required exits and the capacity of these exits.

The occupant load may not be reduced below a minimum specified in the code, regardless of the number of people actually expected. However, if the actual occupant load will exceed the minimum specified in the code, the actual occupant loading is used.

Though each code specifies how the occupant load is to be calculated, the general method is to divide the total gross floor area by a minimum design density of 200 sq. ft. per person. The only exception is 300 sq. ft. per person in one and two family dwellings under the Uniform Building Code. The occupant load for each floor is also computed though the method may vary somewhat. (BOCA: 606.0; UBC: 3301(d), Table 33-A; SBCC: 1105.1; NFPA: 5-3.1, 11-1.5).

1. NUMBER OF EXITS

SUMMARY OF CODE REQUIREMENTS AND INTENT

The codes specify the minimum number of exits that must be provided. Other considerations such as travel distance, remoteness, or capacity of existing exits may require additional exits to be provided. These issues are discussed separately and, therefore, are not considered here.

Code Intent

Requirements for a minimum number of exits are established to increase the reliability of the means of egress system. The intent is that for any single fire ignition that prohibits travel to one exit, there will be an alternate exit that can be used. This does not address multiple fire ignitions, as may be likely with fires that are incendiary (intentionally set).

Having a minimum of two means of escape is one of the most fundamental principles of life safety from fire. The provision that certain occupancy uses only require one exit usually carries a parallel requirement for operable windows of specified minimum dimensions, so even these buildings could be considered to have two means of escape. Every effort should be made to comply with the requirements for the number of required exits, and variances should be granted only in the most exceptional case of hardship or where the hazard is clearly small.

Code Analysis

BASIC BUILDING CODE - 1978

Not less than two exitways serving every story, except in one and two family dwellings, with the following exceptions where one exitway is accepted (609.2, 609.3):

- on the first story of buildings 2000 sq. ft. or less with an occupancy load less than 50 on the first story;
- residential multi-family buildings, two stories or less, with four or less dwelling units per floor, maximum exitway access travel of 50 ft., minimum one hour fire resistance rating of exitway enclosure, and minimum one hour opening protection.

UNIFORM BUILDING CODE - 1979

One exit is required from every building or usable protion thereof, except if there are over ten occupants, there must be two exits. Floors above the first story having an occupant load of more than ten shall have not less than two exits, subject to the following two exceptions:

- unless required elsewhere, only one exit shall be required from a second floor area within an individual dwelling unit;
- two or more dwelling units on the second floor may have access to only one common exit when the total occupant load does not exceed ten.

Floors above the second story and basements require not less than two exits except when used exclusively for the service of the building; only one exit shall be required from a basement within an individual dwelling unit. Every story or portion thereof having an occupant load of 501 to 1000 shall have not less than three exits; four exits are required when the occupant load exceeds 1000. (3302(a), Table 33-A, A-1215 (b,d)).

STANDARD BUILDING CODE - 1979

Not less than two independent exits except for one and two family dwellings and other exceptions noted below.

Minimum Number of Exits	Occupant Load
2	50-500
3	501-1000
4	more than 1000

Residential occupancies having not more than four dwelling units per floor, less than 3500 sq. ft. per floor, and less than three stories in height may be served by one common exit. The travel distance from the entrance door of any living unit to the single exit cannot exceed 30ft. (1103.2).

NFPA LIFE SAFETY CODE - 1976

Two separate exits are required with the following exceptions:

- one and two family dwellings;
- a unit with direct exit to the street at ground level, by an outside stairway, or by a one-hour rated enclosed stair serving only that apartment;
- any height building with four or less units per floor with direct access to a smokeproof tower or outside stair (20 ft. maximum travel distance);
- building three stories or less with one-hour exit and protected openings, corridors with one-hour rating, 20 ft. maximum travel distance (11-3.2.4).

Summary

A minimum of two exits is generally required, although some residential occupancies can have only one if certain requirements are met.

IDENTIFYING EXISTING CONDITIONS

Determine the required number of exits by considering (depending on the particular code in force):

- occupancy (one and two family vs. multiple dwelling)
- area (for computation of occupant load)
- number of dwelling units
- number of stories;
- arrangement of spaces (service rooms, two story dwelling units, etc.).

Determine the number of apparent exits in the proposed building, by counting the following exit elements discharging to a public way:

- exterior exit door
- horizontal exit
- exit passageway
- lobby or vestibule
- interior stairway
- exterior stairway
- ramp
- fire escape

The number of exits is "apparent" because an element may be determined not to be an acceptable exit element because of violation of some other code provisions addressed later in this Guideline.

Note that several required stairways and passageways may combine to discharge through a single exit passageway, lobby or vestibule, though limits are imposed by some codes.

PROBLEMS AND PROPOSED SOLUTIONS

1.1
Problem: One exit available in a three story building when two exits are required.

Solution: Consider adding a smoke detection system providing an alarm to all building occupants, or a total automatic suppression system. This solution should be considered only if each story arrangement meets the special conditions for a single exit (e.g., number of occupants or dwelling units, distance of exitway access travel, enclosure of exitway), and the stairway is well designed (dimensions as required by code, handrails, illumination, etc.).

Discussion: The detection system will allow additional time for escape while the fire is still developing. The suppression system will retard the growth of the fire while providing an alarm to the building occupants. The fact that a single exit is allowed by code for the specified arrangement up to two stories reflects the view that fire is unlikely to block the single exit due to

the distance limitation on exitway access and the requirement of the exitway enclosure.

1.2
Problem: One exit available in a building over three stories.

Solution: Possible consideration should be given to making the single exit a smokeproof tower or an exterior stair. This solution should be considered only if each story arrangement complies with the condition for a single exit (e.g., number of occupants or dwelling units, distance of stairway access travel).

Discussion: This solution is acceptable under the Life Safety Code, but is not recognized by any of the model codes or by most building codes. However, it is the traditional design method in Europe and much of the world. This solution should be considered only after extensive analysis, taking into account local firefighting capabilities.

1.3
Problem: A building has two or more exits, but fewer than required.

Solution: If three exits are required, consider accepting two exits if the building is provided with a total automatic suppression system. (No reduction of exits is recommended if a detection system is used, except as discussed in Problem 1.1 above.) If four exits are required, consider accepting three exits if the building is provided with a total automatic suppression system, and if the number of people in the building is not significantly higher than the smallest occupant load specified in the code for which four exits must be provided.

Discussion: The suppression system will retard the growth of the fire while providing an alarm to the building occupants, thereby allowing the extra time needed to escape through the reduced number of exits. The number of exits should never be reduced by more than one.

Note that the number of required exits is only a minimum. Consideration of arrangement, travel distance, capacity, etc. may require that either additional exits be provided, or that a reduction in the number as suggested in this Guideline not be permitted.

1.4
Problem: Less exits are available than required.

Solution: Consider the use of escape systems, such as fire escapes ladders, fire balconies, etc. which are not normally accepted by codes as exit elements for new construction, in order to provide the new construction, in order to provide the required number of exits.

Discussion: In accepting this solution, an analysis should be made which takes into account both the capacities of anticipated building occupants, and the local firefighting capabilities.

2. HORIZONTAL EXITS

SUMMARY OF CODE REQUIREMENTS AND INTENT

Code Intent

The code intent is to provide an area of refuge within the building. A horizontal exit is a passage from one building area to another area. The areas must be separated by fire resistant construction with the appropriate opening protection (self-closing or automatic closing fire doors).

A horizontal exit does not have to be limited to one building, and can be a bridge or protected passageway from one building to another.

Code Analysis

A horizontal exit is a way of passage from a building to a protected area of refuge, on approximately the same level, within the same or another building. The area of refuge must afford safety from fire and smoke.

Walls or partitions forming the horizontal exits must have a fire resistance rating of two hours. Opening protection (e.g., fire doors) must have a fire resistance rating of 1½ hours. Fire doors in horizontal exits must be either self-closing or automatically close upon activation of a smoke detector, except that only automatic doors are allowed under the Uniform Building Code. Doors must swing in the direction of exit travel.

The Standard and Life Safety Codes provide that horizontal exits cannot comprise more than one-half the required exits. The Uniform, Standard and Life Safety Codes require that the area of refuge have an enclosed stair, door or other "standard" exit that leads directly to the exterior. The Basic Code requires one interior stairway or smoke-proof enclosure on each side of the horizontal exit in multi-story buildings.

The area of refuge must be of sufficient area to be occupied by the total occupant load of the connected areas based upon three sq. ft. per person (net). The codes contain various other prescriptive requirements relating to dimensions, materials and hardware. (BOCA: 614.0; UBC: 3307; SBCC: 1119; NFPA: 5-2.4)

IDENTIFYING EXISTING CONDITIONS

Determine the fire resistance rating of the wall-partition assembly and protection of openings by reference to the code in effect, current or past listings, labels, or Volume 3 of the Rehabilitation Guidelines: Fire Ratings of Archaic Materials and Assemblies.

PROBLEMS OF NONCOMPLIANCE AND PROPOSED SOLUTIONS

2.1

Problem: Fire resistance rating of the wall or partition, as determined in 2. above, below that required by code.

Solution: Upgrade the wall or partition construction to meet code requirements.

Discussion: The fire resistance of the corridor enclosure should be improved by repairing the existing construction or adding a new layer(s) of fire rated materials. See Volume 3 of the Rehabilitation Guidelines: Fire Ratings of Archaic Materials and Assemblies.

-or-

Solution: Accept wall or partition of one hour fire resistance if building provided with automatic detection system providing alarm to occupants of that floor.

Discussion: The added time provided by the detection system will permit the occupants to escape into the area of refuge, and from there to the outside of the building.

2.2

Problem: Fire resistance of the opening protection as determined in 2. above, below that required by code.

Solution: Install local sprinklers over opening protection having a minimum fire resistance rating of one hour. Such sprinklers may be connected to the domestic water supply. Opening protection with a fire resistance rating of less than one hour must either be upgraded to one hour or replaced.

Discussion: The reduced temperature rise resulting from the local sprinkler's water spray will compensate for the reduced fire resistance rating (one hour v. 1½ hours).

3. INTERIOR STAIRS/ENCLOSURES

SUMMARY OF CODE REQUIREMENTS AND INTENT

Enclosed stairs are recognized as an exit by all codes if they are properly designed and constructed. In multi-story buildings they are the most likely type of exit to be encountered. They provide a protected means for evacuation of a building by its occupants. By their nature as vertical shaft through a building, stairs also provide a potential path for the spread of fire from floor to floor.

Code Intent

Requirements for an enclosure of stairs with a minimum fire resistance rating are established in order to achieve two objectives:

- to provide a protected way from any story of a building to a public area or to an area of refuge;
- to limit the spread of fire from floor to floor.

Code Analysis

BASIC BUILDING CODE - 1978

Required interior exitway stairs must have an enclosure of 1-hour fire resistance rating in buildings three stories or less, 2-hour fire resistance rating in buildings four stories or more. Stairs within a single dwelling unit are excepted. Also excepted, when automatic sprinkler protection is provided, are stairs between no more than three communicating floors close to street level which serve no more than one-half the required occupant load and which have adequate capacity for all occupants of all the communicating levels.

Stairway doors must be self-closing and have a 1-hour fire resistance rating in 1-hour construction and 1½ hour rating in 2-hour construction. Other openings are limited in area and must be protected. (616.9.2)

UNIFORM BUILDING CODE - 1979

Existing apartment houses are governed by Appendix Chapter 12, Existing Buildings. Every interior stairway must be enclosed with walls of at least 1-hour fire resistive construction. Wood lath and plaster in good condition is acceptable as 1-hour construction for this purpose. The stairway need not be enclosed in a continuous shaft. Enclosures are not required if an automatic sprinkler system is provided in all portions of the building except apartments.

Stairway doors must be self-closing, tight fitting, smoke and draft control doors with a rating of 20 minutes.

STANDARD BUILDING CODE - 1979

Required exit stairs must be enclosed in 1-hour fire resistive construction in buildings three or less stories in height; 2-hour fire resistive construction in buildings four or more stories in height. Exceptions are similar to those noted above for the Basic Building Code. (1106)

Stair doors must be 1-1/2 hour rating assemblies for 2-hour walls, and 1-hour rating assemblies for 1-hour walls.

NFPA LIFE SAFETY CODE - 1976

Stairways must be protected as follows:

Fire resistance of walls in buildings of one - three stories shall be 1-hour; four or more stories, 2-hours. Fire protection rating of doors in buildings of one - three stories shall be 3/4hour; In buildings provided with total automatic sprinkler protection, the fire resistance of walls in buildings of one - three stories may be reduced to 3/4 hours; four or more stories, 1-hour. The fire protection rating of doors in sprinklered buildings of any height shall be 3/4 hour. (11-3.8.3.1.1)

Exceptions, including the exception allowing unenclosed stairs as part of communicating floors, are similar to those noted above for the Basis Building Code. (6-1)

Summary

The Basic, Standard, and NFPA Life Safety Code generally have identical provisions (2-hours with 1½ hour door over three stories; 1-hour enclosure and door below four stories), except that NFPA requires only a 3/4 hour door in a 1-hour stair enclosure. The Uniform Code Appendix Chapter 12 imposes much more lenient requirements for existing residential buildings.

IDENTIFYING EXISTING CONDITIONS

- Determine location of all unenclosed stairs.
- Determine the fire resistance rating of stair enclosures and doors by reference to the code in effect, current listing, or Volume 3 of the Rehabilitation Guidelines: Fire Ratings of Archaic Materials and Assemblies.

PROBLEMS OF NONCOMPLIANCE AND PROPOSED SOLUTIONS

3.1
Problem: An unenclosed stair is used for egress and does not meet the applicable code exception for communicating floors.

Solution: The stair may be enclosed at each story by the fire resistive construction required for the stair enclosure. The walls forming this enclosure may be located on each story wherever convenient, but as close as possible to the stair.

If, in implementing this arrangement, a limited number of apartment doors will be required to open directly into the stair enclosure, these doors must be automatic closing doors, rated as required for stairway doors by the code in effect, and must meet all other requirements for stairway doors.

Discussion: The proposed solution provides a protected way of escape from any story while limiting the potential of fire spreading from floor to floor.

3.2
Problem: A 1-hour enclosure is required, and an unenclosed stair does not meet the applicable code exceptions for communicating floors.

Solution: Consider enclosing the stair with a wired glass partition in a metal frame providing 3/4 hour fire resistance.

Discussion: This solution is often least objectionable from architectural and cost considerations. Reducing the required fire resistance rating from 1 hour to 45 minutes should still allow adequate time for safe escape. Judgement should be exercised to assure that the occupant load is not excessive for this solution.

3.3
Problem: The fire resistance rating of the stair enclosure, as determined above, is below that required by the code in effect.

Solution: The fire resistance of the stair enclosure should be improved by repairing the existing construction or adding a new layer(s) of fire rated materials. See Volume 3 of the Rehabilitation Guidelines: Fire Ratings of Archaic Materials and Assemblies.

4. EXTERIOR EXIT STAIRS

SUMMARY OF CODE REQUIREMENTS AND INTENT

Code Intent

The code intent for regulating means of egress components is to limit egress routes which require too much time or are too difficult to traverse and afford too little fire protection. An important consideration for an exterior stair is its proximity to openings in the exterior of the building. A fire in the interior could break out exterior windows and cause the stair to be impassable.

A visual enclosure is sometimes required for exterior or outside stairs so that acrophobia (fear of heights) will not impede travel

or lead to panic.

Code Analysis

BASIC BUILDING CODE - 1978

Exterior stairs may be used: (1) in buildings not exceeding five stories or 65 feet in height; and (2) where at least one door from each tenant opens onto a roofed-over open porch or balcony leading to the stairway. In buildings three or more stories in height, openings below or within 10 feet horizontally of the exterior stairs must be protected by automatic doors and windows of 3/4 hour fire resistance. Exterior stairs must conform to the requirements for interior stairs in all other respects. (619.0)

UNIFORM BUILDING CODE - 1979

Exterior stairs must meet the requirements for inside stairs except for opening protection. In buildings three or more stories in height, openings below or within 10 feet measured horizontally must be protected by a self-closing fire assembly having a 3/4 hour fire resistive rating. In existing buildings, the only requirements are that exterior stairs must be noncombustible or of wood of not less than 2-inch nominal thickness with solid treads and risers. (3305; Appendix - Chapter 12, 1215(g)).

STANDARD BUILDING CODE - 1979

Exterior stairs may be used: (1) in buildings not exceeding six stories or 75 feet in height; and (2) where at least one door from each tenant opens onto a roofed-over open porch or balcony leading to the stairway. Openings below and within 10 feet horizontally of the exterior stair must be protected with 3/4 hour fire resistive automatic opening protectives; opening protection is not required for buildings not more than three stories in height where all parts of the exterior stair are at least 6 feet from the building wall. Exterior stairs must conform to the requirements for interior stairs in all other respects. (1129)

NFPA LIFE SAFETY CODE - 1976

Where interior stairs are required to be enclosed, exterior stairs must be separated from the interior of the building by fire resistive walls as required for interior stair enclosures with fire doors or fixed wire glass windows protecting any openings therein. Such protection is not required in buildings three stories or less in height where there is a remote second exit. Other openings within specified distances must be protected. A "visual" enclosure must be provided to protect persons afraid of heights. Exterior stairs must conform to the requirements of interior stairs in all other respects. (5-2.5)

IDENTIFYING EXISTING CONDITIONS

- Determine the fire resistance rating of the protection of walls or openings within or adjacent to the exterior stairs by reference to labels, the code in effect, current listings or Volume 3 of the Rehabilitation Guidelines: Fire Ratings of Archaic Materials and Assemblies.

PROBLEMS OF NONCOMPLIANCE AND PROPOSED SOLUTIONS

4.1

Problem: Fire resistance of the opening protection as determined above below that required.

Solution: Upgrade the fire resistance of the opening protection by repairing the existing construction or adding a new layer(s) of fire rated materials. See Volume 3 of the Rehabilitation Guidelines: Fire Ratings of Archaic Materials and Assemblies.

-or-

Solution: Install local sprinklers over opening protection. Such sprinklers may be connected to the domestic water supply.

Discussion: The water spray on the exposed surface will compensate for the reduced fire resistance rating.

5. FIRE ESCAPE STAIRS

SUMMARY OF CODE REQUIREMENTS AND INTENT

Code Intent

The code intent is to regulate the quality of the required exits. Fire escapes are not favored because they are more difficult to traverse and afford less protection to occupants than other types of exits, such as enclosed interior stairs or exit passageways. However, properly designed and protected fire escapes can be safely used and provide a practical solution when the existing number of exits or exit capacity is less than required.

Code Analysis

BASIC BUILDING CODE - 1978

Fire escapes are permitted only on existing buildings, and then only when "more adequate exitway facilities cannot be provided." Fire escapes cannot provide more than 50% of the required exit capacity. Doors and windows "along the fire escape" must be protected with 3/4 hour fire resistance rated opening protection (621.0).

UNIFORM BUILDING CODE - 1979

Fire escapes may be used as one means of egress in existing buildings. Under specified conditions a "ladder device" may be used in lieu of fire escape." There are no requirements for protection of adjacent openings. (Appendix - Chapter 12, 1215(h))

STANDARD BUILDING CODE - 1979

If "more adequate exit facilities cannot be provided," fire escapes can be used on existing buildings four stories or less in height. Fire escapes cannot provide more than 50% of the required exit capacity. All openings within 10 ft. of fire escapes must be protected with approved opening protactives of at least 3/4 hour fire resistance (1116).

NFPA LIFE SAFETY CODE - 1976

Fire escape stairs may be used only in existing buildings, but shall not constitute more than 50% of the required exit capacity. Openings within specified limits "shall be completely protected by approved fire doors or metal-frame wire glass windows." (5-2.9)

IDENTIFYING EXISTING CONDITIONS

- Determine the fire resistance rating of the protection of openings by reference to labels, the code in effect, current listings, or Volume 3 of the Rehabilitation Guidelines: Fire Ratings of Archaic Materials and Assemblies.

PROBLEMS OF NONCOMPLIANCE AND PROPOSED SOLUTIONS

5.1
Problem: Fire resistance of the opening protection as determined above below that required.

Solution: Upgrade the fire resistance of the opening protection by repairing the existing construction or adding a new layer(s) of the fire rated materials. See Volume 3 of the Rehabilitation Guidelines: Fire Ratings of Archaic Materials and Assemblies.

- or -

Solution: Install local sprinklers over opening protection. Such sprinklers may be connected to the domestic water supply.

Discussion: The water spray on the exposed surface will compensate for the reduced fire resistance rating.

6. ARRANGEMENT OF EXITS

SUMMARY OF CODE REQUIREMENTS AND INTENT

Code Intent

The intent of providing exit remoteness, when two or more exits are required, is to minimize the probability that access to the exits will be blocked by any one fire. The term "remote" is subjective and frequently a matter of interpretation.

Exits which appear to be remote from each other sometimes converge at a distant point. Stairways discharging into a common lobby or passageway are common examples. These exits are not truly remote because a blockage at the point of confluence renders both exits useless.

Code Analysis

Exits must be located so that they are discernible and have unobstructed access. They also must be arranged to lead directly to the street. When more than one exit is required, exits must be as remote from each other as practicable, and must be arranged to provide direct access in separate directions. Exits shall be arranged and constructed as to minimize any possibility that both may be blocked by any one fire or other emergency condition. (BOCA: 602.2, 602.3; SBCC: 1103.1; NFPA: 5-5)

The Uniform Building Code has a prescriptive technique for determining exit remoteness. If two exits are required, they shall be placed a distance apart equal to not less than one half the length of the maximum overall diagonal dimension of the building or area to be served measured in a straight line between exits. An exception is made for exit enclosures interconnected by an approved corridor. Where three or more exits are required, they must be arranged a reasonable distance apart so that if one becomes blocked the others will be available (3302c).

IDENTIFYING EXISTING CONDITIONS

The arrangement of the acceptable exit components will be noted on the building plans or may be studied by a visual inspection of the physical structure.

PROBLEMS OF NONCOMPLIANCE AND PROPOSED SOLUTIONS

6.1
Problem: Required exits not remote from one another.

Solution: Separate the non-remote exits by a smoke barrier.

Discussion: With certain building configurations it is possible to isolate non-remote exits from one another. By constructing smoke barrier partitions, the requirement of direct access to the exits in separate directions can be met. Figure 1 illustrates this concept.

No matter where the fire may originate, any occupant can safely pass from one zone into another. This approach would not work for the building in Figure 2 because these exits, though separated into separate zones, cannot be reached by moving in separate directions: a fire blocking one exit would block the second.

ACCEPTABLE

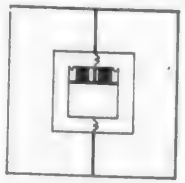


FIGURE 1

NOT ACCEPTABLE

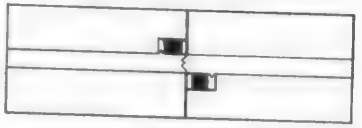


FIGURE 2

The smoke partitions could be constructed of wire glass, gypsum or other suitable materials. The doors must allow travel in either direction, and minimum corridor or hallway dimensions should be observed as closely as possible. Travel distance limitations may be violated by this approach. Slight excesses can be tolerated because the barrier will keep half the corridor free of smoke. Doors may remain in the open position provided they will close automatically upon the activation of a local smoke detector and the manual alarm, smoke detection or suppression systems, if present.

- or -

Solution: Provide an additional exit (e.g., stair, fire escape, fire balcony).

Discussion:

If separation of the exits as discussed above is not possible, then additional exits must be provided so that all occupants will have remote access to the required number of exits. The quality of the additional exits (e.g., enclosed stair v. ladder) will depend upon the use and occupancy of the building.

7. TRAVEL DISTANCE

SUMMARY OF CODE REQUIREMENTS AND INTENT

The codes specify maximum travel distance to the nearest exit.

Code Intent

The intent of requirements governing the maximum travel distance to an exit is to limit the time an occupant needs to reach an exit. When combined with the requirements for a minimum number of exits and for exit remoteness, the limitation on travel distance is intended to assure that even if one exit is blocked by the fire, any occupant will still be able to reach a location of refuge before the fire has spread in a manner as to prevent it. The actual time for escape implied by the maximum travel distance limitation is not explicitly stated.

Code Analysis

BASIC BUILDING CODE - 1978

Length of "exitway access travel" to "an approved exitway" (defined as "that portion of a means of egress which is separated from all other spaces of a building by construction or equipment as required in this code to provide a protected way of travel to the exitway discharge") is as follows:

Without Fire Suppression System	100 feet
With Fire Suppression System	150 feet

If the travel distance within a living unit is less than 50 ft., or 100 ft. if sprinklered, the distance of travel is measured from the corridor entrance (607.4).

UNIFORM BUILDING CODE - 1979

Maximum distance of travel "from any point to an exterior exit door, horizontal exit, exit passageway or an enclosed stairway" is as follows:

Without Automatic Sprinklers	150 feet
With Automatic Sprinklers	200 feet

These distances may be increased 100 ft. when the last 150 ft. is within a corridor that meets specific requirements as to width height, obstruction, dead ends and openings 3302(d).

STANDARD BUILDING CODE - 1979

Maximum travel distance from any point to the "nearest exit" (defined as "that portion of a means of egress which is separated from the area of the building from which escape is to be made, by walls, floors . . . which provides the protected path . . . to the exterior . . .") is as follows:

Unsprinklered	150 feet
Sprinklered	200 feet

If the travel distance within a living unit is less that 50 feet, the distance of travel to an exit is measured from the corridor entrance (1103.1).

NFPA LIFE SAFETY CODE - 1976

The following are the requirements for travel distance (11-3.5, 11-3.6, 11-3.7, 11-3.8):

	To the "nearest exit" from an apartment entrance door	To a Corridor door from any room door
No Sprinklers or Detection	100 ft.	50 ft.
Automatic Detectors	150 ft.	75 ft.
Partial Sprinkler Protection	150 ft.	50 ft.
Total Sprinkler Protection	150 ft.	100 ft.

"Exit" is defined similarly to the definition of "exitway."

Summary

The codes have varying dimensional requirements for travel distance. All allow an increase in exit travel distance if there are automatic sprinklers. Only NFPA 101 allows an increase with automatic detection. No other code recognizes automatic detection as a compliance alternate.

The UBC differs from the other codes by specifying the four egress elements to which the travel distance is to be measured.

IDENTIFYING EXISTING CONDITIONS

Determine the distance from the most remote point on every story of the building or from the most remote apartment entrance door (depending on the local code in effect) to the nearest acceptable exit element. Measure the distance along the most direct natural path of travel.

PROBLEMS AND PROPOSED SOLUTIONS

7.1
Problem: Measured travel distance exceeds maximum travel distance specified in applicable code.

Three alternative solutions to this problem should be considered:

Solution: Travel distance up to 50 ft. greater than the maximum should be acceptable if the path is broken up by an effective smoke barrier with automatic closing door, unless the building is equipped with an automatic suppression system and the allowable travel distance has already been increased. The separation of non-remote exits (Section C: ARRANGEMENT OF EXITS) is a special application of this approach.

The smoke barrier could be constructed of wire glass, gypsum or other suitable materials. The doors must allow travel in either direction, and minimum corridor or hallway dimensions should be observed as closely as possible.

Discussion: The added compartmentation offered by the smoke barrier reduces the chance that the entire travel path would be blocked by smoke after a given period of time, thereby compensating for the added escape time due to a longer travel distance.

- or -

Solution: Travel distance up to 50 ft. should be acceptable if all the apartments are equipped with individual smoke detectors and the building is equipped with an automatic or manual alarm, unless the building is equipped with an automatic suppression system and the allowable travel distance has already been increased.

Discussion: The combination of individual unit smoke detectors and building alarm provides early detection of the fire and the opportunity to warn all building occupants, thereby compensating for the longer travel time implied by the longer travel distance. Fire detectors are not acceptable for this solution, as they do not detect the fire as early as smoke detectors.

- or -

Solution: Consider the addition of exterior stairs or of escape systems, such as fire escapes, ladders, fire balconies, etc., which are not normally accepted as exit elements for new construction, in order to reduce the travel distance.

Discussion: In accepting this solution, an analysis should be made which takes into account both the capacities of anticipated occupants and local firefighting capabilities.

8. DEAD-END TRAVEL

SUMMARY OF CODE REQUIREMENTS AND INTENT

Code Intent

Dead-end corridors of any length are undesirable features in buildings for two reasons. If a person has to use a dead-end corridor as part of the exit access (no choice of travel to exits), they could be trapped by a fire or smoke between them and the exits. The other reason for not having dead-ends is that people moving within the exit access can enter the dead-end, especially under smoky or low light conditions,

and become trapped or confused. Some controversy exists as to which concern the codes are intended to address, if not both. The answer is important because the design solutions differ.

The Basic, Uniform and Standard Building Codes use the term "dead-end" but do not define it. The Life Safety Code uses the phrase "maximum single path corridor length," which would indicate a concern for the availablilty of two remote exits. A close reading of the Uniform Code also favors this interpretation. The Basic Code appears to focus upon the individual in the corridor who may turn off onto a dead-end corridor or hallway. The Standard Code is equally susceptible to either interpretation.

Code Analysis

The Basic, Uniform and Standard Building Codes impose a 20 ft. maximum length for dead-ends (BOCA: 610.2;UBC:3304e; SBC: 1104.3). The Life Safety Code also imposes a maximum single path corridor length of 20 ft., except that lengths of 35 ft are acceptable in existing or totally sprinklered buildings. (11-3.5, 11-3.6, 11-3.7, 11-3.8).

IDENTIFYING EXISTING CONDITIONS

There are two approaches to the identification of paths of dead-end travel. The result may not be the same in both instances.

From the perspective of an occupant in a corridor moving towards a proper exit(s), a dead-end is any path of travel onto which the occupant could mistakenly turn that does not lead to an exit. The length of the dead-end is the maximum distance that the occupant could travel before realizing the mistake, i.e., to the end of the dead-end path.

From the perspective of an occupant moving from an individual dwelling unit into the corridor, a dead-end is any path of travel for which no choice of exits exists. This assumes that two or more exits are required. The length of the dead-end is the maximum distance that any occupant entering onto the corridor would have to travel until paths to remote exits become available. The dead-end corridor may extend beyond the most remote point of access from a dwelling unit to the corridor, e.g., to a window or janitor's closet. However, it is assumed that the occupants, familiar with their surroundings, would move towards, not away from, the nearest exit. Therefore, for this perspective only, the length of the dead-end does not include the length of the path that does not lead to an exit.

PROBLEMS OF NONCOMPLIANCE AND PROPOSED SOLUTIONS

8.1
Problem: Excessive lengths of dead-end travel.

Solution: Provide an additional exit to eliminate dead-end.

Discussion: The most direct solution is to construct an exit at or near the end of the dead-end path. A person turning off the main corridor would still have access to an exit; a person leaving an individual dwelling unit would have a choice of two remote exits. This exit must be directly accessible from the corridor or hallway. Higher quality exit components such as enclosed or open stairs are preferred. Fire escapes or balconies could be accepted depending upon the nature and characteristics of the occupant loading, fire department capabilities, building height, etc.

- or -

Solution: Construct a physical partition limiting the path of dead-end travel.

Discussion: By constructing a physical partition, a person who mistakenly turns off the proper path onto a dead-end would be alerted to his mistake. The distance from the proper path to the partition must be within the limits for dead-ends specified within the respective codes, but should be less than that allowed whenever practicable. The partition need not have any fire resistance rating. Any doors may be kept in the open position provided they shall close automatically upon the activation of a local smoke detector and the manual alarm, detection and suppression systems, if the latter are otherwise required. The partition shall be clearly marked to indicate the path is NOT AN EXIT.

This solution does not provide two remote exits for those occupants whose dwelling units access onto the dead-end path. While the codes are not clear on this issue, the following analysis has been used. The portion of the building served by an excessive dead-end path is analyzed as though it were a separate building. Then, the number of exits required for this portion is determined. If only one exit is required, then the building is considered to be in compliance because the dead-end path still provides one path of escape. The Uniform Building Code provides that "every building or USABLE PORTION THEREOF shall have at least one exit." (3302 (a)) (emphasis added). Two exits are required only when certain limits are exceeded.

Travel distances for the dwelling units in this portion of the building are computed as follows:

The regular travel distance limitations outlined above must be met. For example, the travel distance from the door of the most remote dwelling unit in that portion of the building to the nearest exit may not exceed 100 ft. in a non-sprinklered building constructed under the Basic Building Code.

Some codes impose a special limitation on travel distance to an exit when only one exit is required. The distance from the door of the most remote dwelling unit to the point where two remote

exits become available must not exceed this limit. The Uniform Building Code has no such limitation. The allowable distances in the Basic and Standard Building Codes are 50 ft. and 30 ft., respectively. Though the Life Safety Code allows dead-ends of 35 ft. in existing buildings, the maximum travel distance when a single exit allowable is only 20 feet.

Should the analysis reveal that two exits are required for this portion of the building, then an addtional exit must be provided.

9. CORRIDORS AND EXTERIOR EXIT BALCONIES (SEPARATION AND FIRE RESISTANCE)

SUMMARY OF CODE REQUIREMENTS AND INTENT

Corridors in R-occupancies are the common and public spaces through which occupants travel from their apartments to an exit element. It is the length of corridors that is usually controlled by code provisions governing travel distance.

The codes establish certain requirements for the separation of corridors from other building spaces. See Guideline G for dimensional requirements placed on corridors.

Code Intent

Fire resistance requirements for corridor enclosures and doors are intended to maintain the integrity of the corridor and prevent flames and smoke from blocking the exit route. This will enable the occupants to safely travel through the corridors to the exits.

Code Analysis

BASIC BUILDING CODE - 1978

A corridor is defined as "a hallway, passageway or other compartmented space providing the occupants with access to the required exitway of the building or floor area." (201.3)

Corridors serving 30 or less occupants (i.e., 6000 sq. ft. or less) may have a zero fire resistance rating. All other corridors must have a fire resistance rating of one hour. Corridor walls must extend from the floor to the ceiling (need not extend through space above suspended ceiling). Doors opening onto corridors serving over 30 occupants must be self-closing or automatic closing, with a 20-minute fire protection rating. (610.4)

Open porches or balconies leading to exterior exitway stairs must be separated on their interior side by a fire resistance rating of one hour in buildings of three stories or less, and of two hours in all other buildings. Doors in such separations must be rated at 3/4 hour and 1½ hours, respectively. Other openings must be protected and limited in area. (619.1.1)

UNIFORM BUILDING CODE - 1979

Corridor is not specifically defined.

Walls of corridors and interior sides of exterior exit balconies serving an occupant load of 30 or more (i.e., 6000 sq. ft.) must be of not less than one-hour fire resistive construction. Ceilings of corridors must be at least that required for a one-hour fire resistive floor/ceiling assembly.

Doors opening onto corridors serving 30 or more occupants must be "tight-fitting smoke and draft control" self-closing or automatic closing door assemblies with a 20-minute fire protection rating. Other openings in corridor walls must be fixed and protected by 1/4" wired glass in steel frames and may not exceed 25% of the wall area separating any room and the corridor. (3304)

Travel distance in a corridor so enclosed may be increased (see Section D: TRAVEL DISTANCE).

STANDARD BUILDING CODE - 1979

Corridors are not specifically degined.

All exit access corridors serving over 30 occupants (i.e., 6000 sq. ft.) must have a minimum fire resistance rating of one hour. An exterior balcony may serve as a corridor (exit access) if it complies with all the requirements of a corridor. Doors opening onto corridors serving over 30 occupants must be self-closing, tight fitting, smoke and draft assemblies with a 20-minute fire protection rating. (702.3, Table 700 and Notes, 1108)

NFPA LIFE SAFETY CODE - 1976

Corridors are not specifically defined.

Walls enclosing exit access corridors must have a fire resistance rating of 1-hour. This rating may be reduced to 3/4 hour and 1/2 hour for buildings with automatic detectors and automatic sprinklers, respectively; 1/2 hour fire resistance is permitted in existing buildings.

Doors opening onto such corridors must have a 20-minute fire protection rating, except that previously approved 1-3/4 inch rated bonded wood core doors and frames may remain in use. (11-3.5.3.1.3 and Exception No. 2, 11-3.6.3.1.3, 11-3.7.3.1.3, 11-3.8.3.1.2)

Summary

The three model codes require enclosures of 1-hour for walls and 20 minutes for doors for corridors serving over 30 occupants. The Life Safety Code requires a similar corridor enclosure, irrespective of occupant loading, but allows reduction of the separation requirement as a function of automatic detection and extinguishment. Only the Life Safety Code accepts lower ratings for existing buildings.

The three model codes disagree on the treatment of exterior exit balconies. The Uniform and Standard Codes treat them as corridors, while the Basic Code seems to be stricter, treating them as parts of "exitways" rather than "exitway access."

IDENTIFYING EXISTING CONDITIONS

Determine the occupant load served by the corridor in question. If it is in excess of the code specified criteria of 30 occupants (or 6000 sq. ft. of area served), proceed with the following:

- Determine the fire resistance rating of the corridor wall assembly by reference to the code in effect, current listings or Volume 3 of the Rehabilitation Guidelines: Fire Ratings of Archaic Materials and Assemblies.
- Determine the fire resistance rating of the corridor doors by reference to labels, the code in effect, current listings, or Volume 3 of the Rehabilitation Guidelines: Fire Ratings of Archaic Materials and Assemblies.
- Identify all other openings in corridor walls, such as transoms, and determine their area and the design of their closing devices, if any.

PROBLEMS AND PROPOSED SOLUTIONS

9.1
Problem: The fire resistance rating of the corridor enclosure, as determined above, is below that required by the code in effect.

Solution: If the corridor wall consists of wood lath and plaster, it should be accepted as having adequate fire resistance, or the fire resistance of the corridor enclosure should be improved by repairing the existing construction or adding a new layer(s) of fire rated materials. See Volume 3 of the Rehabilitation Guidelines: Fire Ratings of Archaic Materials and Assemblies.

- or -

Solution: A corridor enclosure of 30 minutes fire resistance should be accepted if the building is equipped with a fully automatic fire suppression system.

Discussion: 30-minute corridor walls with an automatic suppression system are acceptable under the Life Safety Code. The automatic suppression system will delay or prevent the fire's penetration into the corridor, thereby compensating for its reduced fire resistance.

9.2
Problem: The fire protection rating of corridor doors is lower than that required by the code in effect.

Solution: Unrated corridor doors should be accepted if they are individually equipped with a local sprinkler which will automatically spray the door in case of a fire on the room side of the corridor door. Such a sprinkler may be connected to the domestic water supply system.

Discussion: The door's reduced temperature rise resulting from the local sprinkler is roughly equivalent to the delayed temperature rise implied by the door rating.

9.3
Problem: The corridor walls have other openings which are inadequately protected as required by the code in effect.

Solution: All transoms should be closed with plasterboard or fixed wired glass. Other openings should be improved by repairing the existing construction or adding a new layer(s) of fire rated materials. See Volume 3 of the Rehabilitation Guidelines: Fire Rating of Archaic Materials and Assemblies.

10. EXIT CAPACITY/WIDTHS

SUMMARY OF CODE REQUIREMENTS AND INTENT

The codes regulate the capacity of the means of egress by relating required widths of the various elements of the means of egress to the occupant load they serve, and by establishing minimum widths for each egress element.

Code Intent

It is the intent of the codes to provide an exit capacity large enough to move the total expected occupant load into the exits before the access to exits becomes untenable.

Safe exiting time is implied in the codes only, and cannot yet be validly calculated. It was, however, discussed when the values for exit capacity were established by the NFPA Life Safety Code committee. Doors and other level egress components are considered to have a rated capacity of 60 persons per minute per 22 inch unit of exit width and stairs are rated at 45 persons per minute per unit of exit width. This is considered a standard 4:3 ratio for pedestrian movement. These values are based on studies by

the National Bureau of Standards and the London Transport Board*. If stairs are sized to a capacity of 75 people per unit, a time of 100 seconds is implied (75 people/unit divided by 45 people/minute-unit). The results are the same for corridor travel.

The 22 inch unit of exit width, which is used in all but the Uniform Building Code, represents the median width of the human body at shoulder height. Its origin is said to be in experience gained by the military.

The UBC requirements actually imply an exit capacity of 100 people per 24 inches of exit width. Using the 22 inch exit unit system this results in about 92 people per exit unit.

Code Analysis

BASIC BUILDING CODE - 1978

Capacity is based on a unit of egress width of 22 inches with 12 inches or more considered as 1/2 unit in addition to one or more units (608.1), except that a 40-inch door is considered to have two units of egress width.

Exit capacity (number of occupants) per unit of egress width (608.2):

	Without Fire Suppression System	With Fire Suppression System
Stairways	75	113
Doors, Ramps, Corridors	100	150

Minimum width:

Corridors, Ramps	44 inches (36 inches in 1- and 2-family dwellings)
Door	32 inches (28 inches in 1- and 2-family dwellings)
Stairway	44 inches (36 inches for occupancy load 50 or less)
Fire Escape	22 inches
Passageway	44 inches or 3/4 of aggregate widths of all stairways and doorways leading thereto, whichever is greater.

*London Transport Board, Second Report of the Operational Research Team on the Capacity of Footways Research Report No. 95 (London : London Transport Board, 1958).

National Bureau of Standards, Design and Construction of Building Exits, Pub. No. M151 (Washington, D.C., NBS, 1935).

UNIFORM BUILDING CODE - 1979

The total width of exits (in feet) cannot be less than the total occupant load of the building divided by 50, divided about equally between the separate exits. The total exit width for any story is based on the occupant load of that story, plus a percentage of the occupant load of other floors which exit through the story under consideration: 50 percent of the first adjacent story above (and below, if applicable); and 25 percent of the story immediately adjacent to the first adjacent story. (3302(b))

Minimum width:

Corridors Exit Balconies	44 inches for occupant load of 10 or more (36 inches within dwelling units (3304(b))
Doors	32 inches
Stairways	44 inches for occupant load over 50; 6 inches for load of 50 or less (30 inches for private stairway (3305(b))
Exit Courts Fire Escape	44 inches or tributary occupant load 29 inches--clear access opening; 18 inches--stairs

STANDARD BUILDING CODE - 1979

Capacity is based on a unit of egress width of 22 inches with 12 inches or more considered as 1/2 unit in addition to one or more units. (1105.2)

Exit capacity (number of persons) per unit of egress width (1105.3):

Stairs	75
Level Travel (Doors, Ramps, Corridors)	100

The minimum width:

Any menas of egress	36 inches (1105.3(e))
Exitway access, Corridors, Ramps	44 inches (36 inches in 1- and 2-family dwellings) (1105.3(g))
Stair	44 inches (36 inches for 50 or less occupants (1115.6(c))
Courts, Passageways	36 inches or aggregate capacity of all tributary means of egress (1112(c)); 44 inches or 3/4 of aggregate tributary stair and door width (1128.2)
Door	32 inches (1117.1(b))
Fire Escape	22 inches--stairs (1116(d))

NFPA LIFE SAFETY CODE - 1976

Capacity is based on a unit of exit width of 22 inches with 12 inches or more considered as 1/2 unit in addition to one or more units (5-3.2)

Exit capacity (number of persons) per unit of exit width (11-1.6.):

Level egress, Class A Ramps, Doors	100 People
Stairways and other types of exits	75 People (See Table 5-2.9.4 for fire escapes.)

Minimum width:

Any exit access, Doors	28 inches
Stairs	44 inches for occupant laod of 50 or more; 36 inches for occupant load of less than 50 (5-2.2.1.2)
Fire Escapes	22 inches (18 inches for 10 or less occupants (5-2.9.4)
Ramps	44 inches for Class A (5-2.6.1.2) 30 inches for Class B (5-2.6.1.2)
Exit Passageway	Aggregate of tributary capacities (5-2.9.3)
Street Floor	Aggregate capacity of street floor and 3/4 of exit units of stairs from other floors discharging through street floor (11-2.2.3.1)

Summary

The Uniform Code differs significantly from the other three codes in determining the required exit capacity. All other use the 22-inch exit unit. The Basic Code allows an increase in the capacity per unit of egress width if the building is sprinklered.

Minimum widths are generally similar for all the codes, except that the Life Safety Code accepts a minimum corridor width of 28 inches, while the other codes require 44 inches in apartment buildings.

IDENTIFYING EXISTING CONDITIONS

- Determine the number of exit units or feet of exit (depending on the code in effect) for each exit element identified in Section A: NUMBER OF EXITS above; for each access corridor or hallway leading from any apartment to an exit; and for each grade level egress. Base the computation on the number of occupants served by the element in question, in accordance with the code in effect.
- Determine the required width of each egress element, corridor or hallway.
- Determine or measure the actual width of each egress element, corridor or hallway, and grade level egress identified above, by field measurement or scaling dimensioned plans.

PROBLEMS AND PROPOSED SOLUTIONS

10.1
Problem: The width of a particular element is less than the minimum width specified in the code in effect.

Solution: If the element is wide enough to provide the required exit capacity and is equal to or greater than some minimal dimension, though, lower than that specified in the code, it should be accepted. This new minimum should be over 22 inches, and 28 inches should be considered, as specified for some elements by the Life Safety Code.

Discussion: In most cases, considerations of functionality (movement of furniture, etc), appearance, and marketability will result in minimum dimensions greater than those suggested above, and may, in fact, have been the reason for the higher minimums specified in current codes. For egress only, however, units of exit width should be adequate. A higher minimum than 22 inches is suggested, since that dimension represents the median width of the human body at shoulder height.

11. CONSTRUCTION DETAILS AND SPECIFICATIONS

SUMMARY OF CODE REQUIREMENTS AND INTENT

Code Intent

The codes set out many other requirements for egress components. Typical areas include: allowable materials, handrails, tread and riser design, landings, platforms, guards, and lighting. The intent of these provisions is to ensure a quality design that will promote safe and easy passability. The individual code requirements have not been set out because they are too numerous and highly specific.

IDENTIFYING EXISTING CONDITIONS

The relevant features should be noted on the building plans or may be studied by a visual inspection of the physical structure.

PROBLEMS OF NON-COMPLIANCE AND PROPOSED SOLUTIONS

Because these provisions tend to be highly specific and detailed, existing egress components will often not be in compliance. However, the impact or effect of the deficiency must be realistically

appraised in light of the number of occupants that will rely upon the egress component in question and their ability to use the egress component as it presently exists. If the numbers are small and the people capable, then minor deviations should be tolerated.

Of the many potential problems, there are three that appear the most common and raise the greatest concern.

11.1
Problem: Existing winding and spiral stairs not permitted under the code in use.

Solution: Allow their continued use if occupants are mobile, agile, and capable of rapid movement under emergency conditions; upgrade stairs in all other respects.

Discussion: Winding or spiral stairs are not favored because the uneven tread pattern and changes in direction can make passage difficult. The use of these stairs could be continued if the occupants can be expected to use them safely (i.e., healthy adults) and the stairs complied in other respects (e.g., not excessively steep or narrow). Lighting should be improved if necessary; emergency lighting, handrails, etc. should be improved or provided.

11.2
Problem: Non-conforming tread and riser dimensions.

Solution: Accept stairs having a minimum run of nine inches and maximum rise of eight inches; upgrade stairs in all other respects.

Discussion: Some codes use the mathematical formula that the sum of (2 x rise) + run must be between 24-25 inches. Such a formula may arbitrarily eliminate stairs which are otherwise quite passable. Stairs exceeding even the limits stated above may be considered for acceptance if the step pattern does not change and the occupancy is such that those who may need the stair in an emergency are familiar with the particular design of the steps. As in 3.1 above, the stairs should be otherwise of high quality and passable. Lighting should be improved if necessary; emergency lighting, handrails, etc., should be improved or provided.

11.3
Problem: Minimum ceiling heights for stairs, passageways, etc.

Solution: Allow the continued use if passable by the occupants; upgrade in all other respects.

Discussion: Low ceiling heights make an exit not only physically difficult to traverse, but can create an impression of closeness or of a closed space that may create a sense of apprehension, particularly if the path is also narrow or somewhat lengthy. If the number of occupants is low so that crowding would not be expected and the distance is not excessive, discretion should be exercised. The familiarty of the occupants with this egress component should also be considered. Lighting, particularly emergency lighting, is very important. A regular pattern of markings showing the direction of the ultimate exit to the outside can also be reassuring. Other aspects of the egress component should be improved or provided if missing.

CHAPTER 2

ELECTRICAL GUIDELINE FOR RESIDENTIAL REHABILITATION

INTRODUCTION

This guideline was developed to facilitate the rehabilitation of residential buildings. It also may be used in the rehabilitation of other, similar occupancies.

The guideline does not address all topics associated with electrical codes, but only those select problem areas most identified with rehabilitation projects. In general, the guideline addresses three subjects:

- establishing standards for electrical rehabilitation;
- inspecting existing electrical installations; and
- problems and solutions for hazardous conditions, adequate load-carrying capacity, and additions, alterations and extensions to existing electrical installations.

It has been long recognized that electrical codes pose special problems for rehabilitation projects. Some jurisdictions have adopted special electrical codes to be used for rehabilitation. For example, the City of Detroit's electrical code for rehabilitation is shown in Appendix 11 to Volume 1 of the Rehabilitation Guidelines. Some of the model electrical codes give the code enforcement authority the responsibility for making interpretations of the rules, for granting exceptions to the rules, and for waiving specific requirements of the code. An example of this "flexible" approach is provided by the National Electrical Code (NEC):

- *"Section 90-2. (c) Special Permission. The authority having jurisdiction for enforcing this Code may grant exception for the installation of conductors and equipment, not under the exclusive control of the electric utilities and used to connect the electric utility supply system to the service entrance conductors of the premises served, provided such installations are outside a building or terminate immediately inside a building wall."*
- *"Section 90-4. Enforcement. This Code is intended to be suitable for mandatory application by governmental bodies exercising legal jurisdiction over electrical installations and for use by insurance inspectors. The authority having jurisdiction of enforcement of the Code will have the responsibility of making interpretations of the rules, for deciding upon the approval of equipment and materials, and for granting the special permission contemplated in a number of the rules."*
- *"In industrial establishments and research and testing facilities, the authority having jurisdiction may waive specific requirements in this Code or permit alternate methods, where it is assured that equivalent objectives can be achieved by establishing and maintaining effective safety and maintenance procedures."*

• *"Section 90-5. Formal Interpretations. To promote uniformity of interpretation and application of the provisions of this Code, the National Electrical Code Committee has established interpretation procedures."*

1. ESTABLISHING STANDARDS FOR ELECTRICAL REHABILITATION

A community or jurisdiction that may wish to use these Guidelines may also have a need to set standards for rehabilitating electrical installations. A process for doing this is discussed in detail in the Guideline for Setting and Adopting Standards for Building Rehabilitation contained in Volume 1 of the Rehabilitation Guidelines.

There are a number of sources of information which may be used as a basis for setting electrical rehabilitation standards. Current electrical codes, such as the NEC, are one such source of rehabilitation standards information. Although these codes principally regulate new construction, and therefore do not adequately address the problems of rehabilitating existing buildings, certain of the provisions of electrical codes for new construction are applicable. For example, those regulating grounding, connections and service ratings can be adopted as electrical rehabilitation standards when a community or jurisdiction wishes to maintain a level of safety in rehabilitated buildings which is the same as that for new construction.

In addition, the "alternative materials and methods" provision of new construction codes provides a concept by which some solutions to problems of electrical rehabilitation can be developed that are different from those prescribed by the current code, but provide an equivalent level of safety.

Property maintenance codes, fire prevention codes, and hazard abatement codes could be another basis for setting electrical rehabilitation standards. As the following excerpts from some of these codes illustrate, they do not contain precise enough information to be useful in setting specific standards. They are useful, however, as a general basis for establishing minimum levels of performance and levels of performance less than those required by new construction codes.

The BOCA Basic Property Maintenance Code states in Section H-602.0, ELECTRICAL FACILITIES:

> *"H-602.1 Outlets required: Where there is electric service available to a structure, every habitable room of a dwelling unit, and every guest room, shall contain at least two (2) separate and remote outlets, one (1) of which may be a ceiling or wall-type electric ligh fixture. In a kitchen three (3) separate and remote wall-type electric convenience outlets or two (2) such convenience outlets and one (1) ceiling or wall-type electric light fixture shall be provided. Every public hall, water closet compartment, bathroom, laundry room or furnace room shall contain at least one (1) electric light fixture. In addition to the electric light fixture in every bathroom and laundry room, there shall be provided at least one (1) electric outlet.*
>
> *"H-602.2 Installation: All electrical equipment, wiring, and appliances shall be installed and maintained in a safe manner in accordance with all applicable laws. All electrical equipment shall be of an approved type."*
>
> *"H-602.3 Defective system: Where it is found, in the opinion of the building official, that the electrical system in a structure constitutes a hazard to the occupants or the structure by reason of inadequate service, improper fusing, insufficient outlets, improper wiring or installation, deterioration or damage, or for similar reasons, he shall require the defects to be corrected to eliminate the hazard."*

Similarly, the BOCA Basic Fire Prevention Code states in SECTION F-105.0, ORDERS TO ELIMINATE DANGEROUS OR HAZARDOUS CONDITIONS, F-105.1 General:

> *"Whenever the fire official or his designated representative shall find in any structure or upon any premises dangerous or hazardous conditions or materials as follows, he shall order such dangerous conditions or materials to be removed or remedied in accordance with the provisions of this code:*
>
> * * *
>
> *7. hazardous conditions arising from defective or improperly used or installed electrical wiring, equipment or appliances;"*

Past electrical codes for new construction are an especially important source of information for electrical rehabilitation standards setting. The levels of safety required by past electrical codes are different from, and may be lower than, the current electrical codes. Past codes, however, are most useful in determining after an on-site inspection whether an existing building currently meets the code under which it was built.

Finally, laws and regulations affecting electrical installations which apply retroactively to exsiting buildings are by definition mandatory standards for electrical rehabilitation.

All of the above, except retroactive laws and regulations which usually are community or jurisdiction specific, have been addressed in the electrical rehabilitation problems and solutions that follow.

2. INSPECTION

In the process of submitting proposed electrical rehabilitation work to a building department, it will be necessary to inspect existing electrical installations when the building official needs more information about the work to be done (see Guideline for Municipal Approval of Building Rehabilitation). Inspections are also an essential part of enforcing property maintenance, fire prevention and hazard abatement codes.

This part of the guideline contains a procedure for conducting inspections of existing electrical installations to determine their physical condition, functional condition and load-carrying capacity.

Even if electrical construction drawings and/or specifications of an existing building were available, they would not be useful in determining the present physical and functional condition of the electrical installation. These conditions can only be determined from an on-site inspection. However, if electrical construction drawings accurately and completely represented the present electrical installation in an existing building, they could be used in conjunction with the current electrical code to calculate the installation's load carrying capacity.

It is recommended that inspections be made by qualified electrical inspectors or licensed electricians.

2.1 Physical Condition

First, determine the physical condition of the existing electrical installation. Inspect the physical condition of parts of the installation which are normally exposed to view.

Next turn off the power, and remove the covers and open the doors of switch boards, panelboards, cabinets and boxes. Then, inspect the physical condition of the exposed, internal components and wiring, as well as the surrounding building construction.

If the condition of the conductor insulation can't be determined by inspection, have an insulation resistance test made. Similarly, if the condition of receptacles can't be determined by inspection, test them by inserting a standard type flexible cord attachment plug.

Detaching fixed utilization equipment such as lighting fixtures, lampholders and appliances (built-in electrical space heaters, for example) to inspect the physical condition of their exposed, internal components and wiring, and the surrounding building construction should also be done. But in older buildings, this may contribute to, or actually cause, defects in equipment, appliances or wiring. Therefore, consider carrying out this type of inspection only when:

1) such wiring, equipment or appliance is part of a rehabilitation plan;

2) problems are evident from the first inspection of parts which are normally exposed to view; or

3) problems of function are evident from inspection.

2.2 Functional Condition

Second, if the physical condition of the installation seems safe enough, determine the functional condition. Turn the power on. Next, with the covers removed and the doors open on equipment to expose circuit breakers, switches, receptacles and other devices, and conductor splices and connections, do the following:

1) operate circuit breakers, switches, other operable devices and fixed utilization equipment;

2) observe the function of operable devices; and

3) observe the operation, and assess the operating temperatures of fixed utilization equipment.

Make inspections to determine the physical and functional conditions of existing electrical installations in accordance with the current code, such as NEC Section 110-3(a). Whenever possible as an aid in assessing an installation's condition, secure information from owners, tenants or building department records about past operating problems that cannot be easily found by inspection, such as the frequency of fuses blowing or short circuits.

2.3 Load Carrying Capacity

Third, determine the load carrying capacity of the existing electrical installation by calculation in accordance with the current code.

3. PROBLEMS AND SOLUTIONS

3.1
Problem. The existing electrical installation has any one or combination of the following conditions which are contrary to the intent of property maintenance, fire prevention and hazard abatement codes:

1) equipment or wiring is missing, broken, disconnected, loosely connected, unsupported, not securely fastened in place, corroded, burnt, cracked, split, or has evidence of physical damage or misuse other than that affecting appearance;

2) equipment is dirty or contains debris;

3) wiring is frayed;

4) labeled or listed equipment or wiring is not installed in accordance with any labeling or listing instructions;

5) circuit breaker, switch, receptacle other device, fixed utilization equipment or wiring is not compatible with the phase, voltage, amperage or type characteristics of the electricity in use;

6) circuit breaker, switch or other operable device has visible evidence of arcing;

7) receptacle contact devices are not firmly in contact with the contact devices of a standard type flexible cord attachment plug when the plug is inserted into the receptacle;

8) neutral is not grounded at the main service entrance equipment location by a properly connected grounding electrode conductor;

9) polarity is reversed in wiring connections to receptacle outlets;

10) fixed utilization equipment, such as a lighting fixture, lampholder or appliance, operates intermittently;

11) building construction adjacent to wiring, equipment or appliance is burnt;

12) service, feeder or branch circuit conductors have evidence of intermittent operation, impaired operation, or cannot otherwise be determined as acceptable when the installation is energized;

13) flexible cord is used as a permanent wiring method, or

15) branch circuit, feeder, switchboard, panelboard or distribution board service rating is inadequate for the load calculated in accordance with the current code.

Solution. Have all such conditions corrected.

Discussion. These conditions are hazards of varying degrees. They are problems associated with defective or improperly used or improperly installed wiring, equipment or appliances. If any one or combination of these conditions is extensive, severe, or occurs frequently in an installation, a building official may judge that an imminent hazard exists. In that case, the hazard must be corrected immediately or the installation disconnected.

If flexible cord is used as a permanent wiring method (condition 14), this may indicate the need for more receptacle outlets (see Problem and Solution 3.8).

3.2
Problem. Circuit breaker, switch, receptacle, other device, fixed utilization equipment, raceway, connector, terminal, splicing device or other fitting is not compatible with the type of conductor used, or the electrical connection doesn't meet the current code, such as NEC Section 110-14.

Solution. Have all such connections of conductors to terminal parts, conductor splices, or conductors joined with splicing devices corrected to meet the current code, such as NEC Section 110-14(a) and 110-14(b); and have all incompatible conductors, devices or equipment corrected to meet the current code, such as NEC Section 110-14, by:

1) replacing existing conductors with new conductors which are compatible with the existing devices or equipment, or

2) replacing existing devices or equipment with new devices or equipment which are compatible with the existing conductors; or

3) installing an insulated conductor "pigtail" compatible with the existing device or equipment.

Discussion. Improper connections and splices, and incompatible conductors, devices and equipment can be hazardous. They are problems associated with defective or improperly installed wiring or equipment. These conditions may, depending upon the number and severity of the problems, be judged an imminent hazard by a building official. If that is the case, the hazard must be corrected immediately or the installation disconnected.

3.3

Problem. An existing appliance branch circuit doesn't have an equipment grounding conductor which is required by the current code.

Solution. Permit ungrounded, non-conforming, existing appliance branch circuits to remain, provided:

1) alternative grounding is provided for appliances by the connection of an equipment grounding conductor to a grounded, metallic, cold water pipe;

2) service equipment, service raceways, service grounded conductors, switchboards and panelboards are grounded in accordance with the current code, such as NEC Article 250, or alternative grounding is provided by the connection of an equipment grounding conductor to a grounded, metallic, cold water pipe; and

3) branch circuit equipment grounding conductors are in accordance with the current code, such as NEC Article 250.

Discussion. This alternative method of grounding existing appliance branch circuits is not the method usually required by code, but it will provide an equivalent level of safety. And, since this alternative method is relatively simple to install, it is an aid to rehabilitation. But, it is important to make sure in such installations that equipment grounding conductors are connected to cold water pipes which are metal and which are grounded. Similarly, make certain that equipment grounding conductors are never connected to metallic, gas supply pipes; this would pose a serious hazard.

3.4

Problem. The size of the service is inadequate for the load as calculated according to the current code.

Solution. Re-calculate the size of the service for the actual connected (installed) load and the loads for circuits calculated according to the current code, provided:

1) the service disconnecting means has a rating not less than the actual connected load;

2) loads established for branch circuits and feeders are determined with the diversities and calculation methods defined in the current code; and

3) all other aspects of the service meet the current code, such as NEC Table 310-16 to 19 including the notes to these Tables, Article 220, Article 240 and Article 230 except Section 230-79(c) for single-family dwellings and Section 230-79(d) for all other occupancies.

Discussion. In determining the actual connected load, include both existing loads which won't be affected by rehabilitation and new loads which are planned as a part of rehabilitation. The probability of the use of room air conditioners should also be considered. By using energy sources other than electricity, electrical loads can be reduced. Therefore, consider the use of other energy sources for cooking, heating and domestic hot water. Determining existing loads and new loads planned as a part of rehabilitation requires judgement. If there is any indication that loads will increase in the future, this should be taken into consideration. Using the actual installed load is a means to control otherwise unnecessary rehabilitation, while maintaining the standards of safety required by the current code.

3.5

Problem. In one and two family dwellings, the existing service rating must be increased by the addition of a second service entrance and a second service disconnect in order to meet the current code or these Guidelines, but space is limited or there are other, similar constraints.

Solution. Add the second service entrance and the second service disconnect at a location different from the existing service disconnect, provided:

1) both disconnects meet the current code, such as NEC Section 230-72(a);

2) permanent warning signs are erected at each location indicating separate service disconnects; and

3) the combined rating of the separate service disconnects is not less than that required by the current code or recommended by other sections of these Guidelines for a single service disconnect.

Discussion. These recommendations are intended to eliminate the potential hazard of installing a single, new, service entrance in an inappropirate location, and are a means to control otherwise unnecessary rehabilitation. Any hazard associated with a "split" service is eliminated by the suggested provisions of the recommendations, and the restriction of split service to residences of no more than two families. A split service installed as recommended is an alternative to the current code which should provide an equivalent level of safety.

3.6

Problem. An existing general purpose branch circuit or feeder is without an equipment grounding conductor, and that is contrary to the current code.

Solution. Allow un-grounded, non-conforming, existing, general purpose branch circuits to remain, provided:

1) no circuit or feeder is overloaded; and

2) no general purpose branch circuit serves loads required by the current code to be served by small appliance branch circuits.

Discussion. An existing general purpose branch circuit without an equipment ground which is inspected and found to still be in acceptable physical and functional condition, and is not overloaded, can be considered to have a history of operating safely. Therefore, its safe operation can be expected to continue, and it can be allowed to remain. It is important that such a circuit doesn't serve as an appliance branch circuit, and that in calculating loads on it, both existing loads which won't be affected by rehabilitation, and new loads which are a result of rehabilitation be used.

3.7
Problem. An existing general purpose branch circuit is to be extended, and it conforms to the current code, except it doesn't have an equipment grounding conductor.

Solution. Permit un-grounded, non-conforming, general purpose branch circuits to be extended to all locations except kitchens, baths, basements and garages.

Discussion. Kitchens, baths, basements and garages represent a particular hazard as compared to other locations. That hazard is reduced by equipment grounding conductors installed according to the current code or these Guidelines.

3.8
Problem. The number of existing receptacle outlets is less than required by the current code.

Solution. Permit fewer receptacle outlets than required by the current code.

Discussion. The number and location of receptacle outlets required for the safe and convenient use (as this bears on safety) of rooms and spaces varies and can best be determined by judgement by communities and jurisdictions individually. Such factors as number of occupants, floor area, room configuration, and window and door locations all affect determining that number and location of receptacle outlets which meets the intent of the current code.

The following is one example of such a reduction in the number of required receptacle outlets:

1) living rooms or living/dining rooms have a minimum of one duplex receptacle outlet on each wall, and the outlets are uniformly spaced relative to room area;

2) other habitable rooms have a minimum of two duplex receptacle outlets uniformly spaced relative to room area;

3) bathrooms have a minimum of one duplex receptacle adjacent to the basin location, and all bathroom, garage and outdoor receptacles have ground fault circuit interruptor protection in accordance with the current code, such as NEC Section 210-8(a);

4) kitchens have a minimum of one, separate, small appliance circuit supplying grounding type duplex electrical outlets;

5) each stair or each stair section has adequate illumination controlled by wall switches located conveniently for ease of use where it is unnecessary to use darkened stairs for their operation, and all stairs to finished rooms have multiple switch control from the head and the foot of the stair;

6) new small appliance circuits are a minimum of 20 ampere capacity; and

7) lighting outlets are provided and installed in accordance with the current code, such as NEC Section 210-26(a).

3.9
Problem. The configuration of access space to, and working space around, electric equipment to permit ready and safe operation and maintenance of the equipment is different from that required by the current code, such as NEC Section 110-16.

Solution. Permit such existing space to remain when the intent of the current code can be met.

Discussion. Equipment accessibility and working space are essential to safety. If the existing space meets the requirements of the past code under which it was constructed, if additional equipment and/or new equipment of a higher service rating is not to be installed, and if the installation has a history of safe operation, maintenance and repair; these considerations may be a basis for permitting the existing space to remain unchanged.

CHAPTER 3

PLUMBING DWV GUIDELINE

FOR

RESIDENTIAL REHABILITATION

INTRODUCTION

Plumbing drainage, waste, and vent (DWV) requirements in building and plumbing codes are often viewed as major rehabilitation problems. Requirements to install new DWV systems in existing buildings which fully comply with current code provisions often lead to extensive additional structural and finish work. There are several aspects to this problem:

- existing vent systems may not comply with code provisions for pipe sizing, connections, use of wet venting, and vent location, although they provide adequate health and safety as installed and used.
- the installation of new vents and lines, even for new fixtures, may be constrained by space available and/or the existing configuration of piping.
- economic DWV materials, such as plastic pipe, may be precluded by material restrictions in the code, or by requirements related to mixtures of materials or their methods of connection.
- the cost-effective use of existing DWV systems in rehabilitation projects requires judgement and flexibility by the municipal building department to a greater extent and in a different manner than in new construction.

This guideline, based on accepted drainage and hydraulic engineering concepts, provides alternate solutions to typical DWV problems faced in building rehabilitation.

USE

This guideline is arranged as follows:

- Part 1, determining the condition of the existing system
- Part 2, determining the capacity of the existing system
- Part 3, relocating fixtures
- Part 4 and Appendix, adding new fixtures to existing DWV systems, extending existing DWV systems, and installing new DWV systems in existing buildings
- Part 5, through-the-wall venting for special conditions

Because the guideline advocates greater flexibility in meeting the health and safety intent of current codes, an understanding of basic drainage and hydraulic concepts is essential to its use. These concepts are described below.

BASIC DRAINAGE AND HYDRAULIC CONCEPTS

Function of the Drainage System

The function of the DWV system is to collect spent water from the various building fixtures and drains and to convey this waste water to the public sewer or other disposal area in a safe and efficient manner.

A "safe manner" means collection and transmission without the emission of sewer gases, foul odors, or suds to the inhabitable area of the building. Traps at the entrances to the DWV system provide water seals which prevent the escape of sewer gasses. Most codes limit the pressure fluctuation within drainage systems to plus or minus 1-inch of water pressure under design load conditions. A more practical limitation, and the one used in this guideline, is to limit the trap seal loss to 1-inch of water under normal conditions of stress. Acceptance of this concept permits the planning and carrying out of simple field tests on existing systems to determine their condition, and to provide a basis for approving modified systems in rehabilitated buildings.

An "efficient manner" means the conveyance of waste water and suspended solids without blockage. The generally accepted criteria to ensure efficient performance is to size the drainage lines such that the horizontal velocity is approximately 2 feet per second, since efficient transport is a function of both velocity and depth of flow.

If the depth is not sufficient, solids will settle out. The depth of flow and water velocity are both influenced by the slope or pitch of the drain line. Increasing the slope from 1/8-inch per foot to 1/4-inch per foot increases the velocity of the water while it decreases the depth of flow. Knowledge and understanding of these characteristics of flow provides the basis for adjusting the slope of existing building drains, which often determines the capacity of the plumbing drainage system.

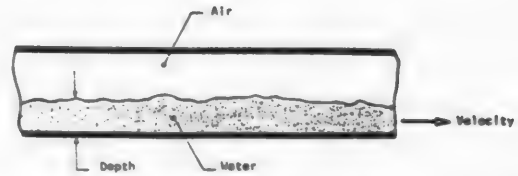
Hydraulic Principles

The rate and volume of discharged spent water from plumbing fixtures and drains, as well as the frequency of fixture use, are important variables to the understanding of the functioning of the DWV system. Frequency of fixture use is high in public buildings, such as stadiums and theaters, and low in residential buildings. Estimating fixture use in residences requires only an estimate of the maximum number and combination of fixtures that may discharge simultaneously. In larger buildings, the fixture unit concept is employed. Existing DWV systems are not normally loaded to capacity; therefore, they will usually accept a limited number of additional fixtures without seriously decreasing the system's safety factor.

The rate at which water exits from plumbing fixtures changes continuously. For water closets, the discharge begins a few seconds after the flush is started and gradually rises to a peak rate of 30 gallons per minute, remaining constant for a few seconds and then gradually falling to zero. The use of water saving closets does not increase drainage problems since their peak discharge rate is similar to conventional fixtures. The discharge time for a lavatory is approximately 12 seconds and the peak flow is about 10 gallons per minute. This low flow rate and short duration suggests that lavatories have only a small influence on the functioning of the DWV system. Bathtub discharge is influenced significantly by the geometry of the outlet piping. In most outlet arrangements, the rate of discharge rises to 12 gallons per minute almost instantly and thereafter decreases continuously as the tub drains.

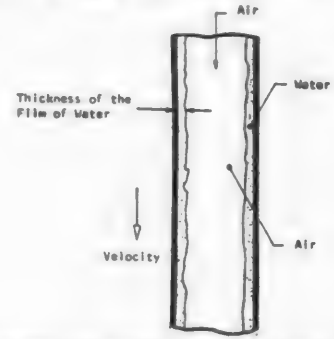
Flow in Drains and Stacks

The flow of spent water in horizontal drainage systems may be described as separated flow since the horizontal drain is generally only partially filled. Water moves through the lower half of the pipe, while air flows through the upper half.



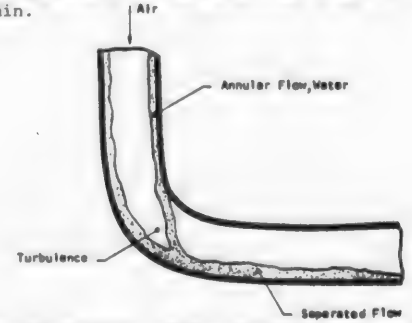
The velocity and depth of the water flow in the drains constantly changes. As the volume of water increases, the depth of flow also increases, displacing the air above it. When most of the normal air space is filled with water, turbulence increases significantly, and even the smallest water pulsations disturb trap seals in the system's plumbing fixtures. Therefore, horizontal drains are designed to flow no more than half full.

The flow in vertical drains or stacks is entirely different. As water enters the stack it attaches itself to the walls of the pipe, forming an annulus. This cylinder of water falls down the pipe, dragging air with it.



The establishment of annular flow is rapid. It occurs within several feet of the point where the water enters the pipe. Increasing the volume of water increases the film thickness. When the volume of water occupies approximately 1/3 of the cross-sectional area of the stack the annular flow breaks down, causing extreme turbulence and pulsations which result in the loss of trap seals. Small diameter vertical pipes close to fixture outlets are susceptible to breakdown of the annular flow which may result in self siphonage of the fixture. It is for this reason that S traps have been prohibited by codes. Modified S traps, where the distance between the trap outlet and the vertical drop is at least two pipe diameters and where the size of the vertical pipe is one diameter larger than the trap inlet, have been found to function without siphonage.

The most critical area in a drainage system is at the base of the stack. In this region the flow must change from the annular flow of the stack to the separated flow of the horizontal drain.



The disturbance at the base of the stack is large, and significant positive pressures are generated which, if not relieved, cause blowback - the passage of water through the trap. If the transition is smooth, much of the air is carried away through the horizontal drain.

Horizontal drains are not able to transport spent water at the same rate as stacks. This results in a phenomenon called hydraulic jump. The change in velocity from approximately 15 feet per second in the stack to 2 feet per second in the horizontal drain forces an increase in the depth of flow. It has been recently found that this rise in the water level occurs much further downstream than the generally accepted 10-pipe diameters. What has been observed in the immediate vicinity of the base of the stack is a washing of the sides of the drain which may cause temporary blockage of fixture drains or vents that enter nearby. Fittings rolled up to 45 degrees are effective in avoiding problems in this area.

Modes of Trap Failure

Plumbing seals may fail, as indicated by an unacceptable degree of trap reduction, by one or more of the following means:

- o self-siphonage, or the breaking of the trap seal as a result of siphonic action by the discharge of the fixtures to which the trap is connected
- o induced siphonage, or the breaking of the trap seal as a result of siphonic action by discharge of fixtures other than the one to which the trap is connected
- blowback, or the emission of air or sewer gas into the inhabited area of a building through a fixture trap

The first of these modes of failure, self-siphonage, is related to fixture characteristics and branch piping. Plumbing fixtures which exhibit a sharp fall off in flow, such as round bottom lavatories, are more sensitive to self-siphonage than those with more gradual changes in flow. Traps serving bathtubs are rarely influenced by tub discharge. Self-venting trap arms and branch drains can be designed through knowledge of the fixture discharge curve and correct pipe sizing.

Induced siphonage and blowback are prevented through correct venting design and installation. Every drainage system has a basic hydraulic capacity which may be increased by the addition of vents. The function of venting is to maintain close to atmospheric pressure in the drainage system so that trap seals will not be disturbed. A sure way to protect the DWV system is to provide individual fixture vents, an obviously expensive approach. Among the more economical alternatives that have been developed, tested, and commonly approved for residential buildings are stack venting and wet venting.

In stack venting, fixture traps are protected by venting provided through the upper portion of the soil or waste pipe. Successful installations require that fixtures be connected to the stack

- independently;
- according to their rate of discharge, with those with the highest rate of discharge placed at the lowest point in the module;
- at those points where the pressure fluctuations are small.

Wet venting is a technique that uses the drainage pipe itself for vent protection of selected fixtures. In practice, wet vents receive only the spent water from fixtures that have a low rate of discharge. These fixtures need not enter the stack independently, and in many installations groups of fixtures connect to one horizontal branch. A variety of wet vented modules have been developed and accepted over the years.

Progressive plumbing designs incorporate wet vented and stack vented modules as major DWV components, supplemented by individually vented fixtures where required by design restraints.

1. DETERMINING THE CONDITION OF THE EXISTING DWV SYSTEM

A. STRUCTURAL SERVICEABILITY

Identifying Existing Conditions

A field inspection of the existing DWV system is required to provide specific information indicative of its overall physical condition. Careful attention should be paid to those areas where the DWV system is exposed to view.

Problems and Proposed Solutions

1.1
Problem. The mechanical strength of existing pipes, fittings, and supports is appreciably lower than that required for new construction and/or the DWV system is inadequately attached to the building. These conditions may be evidenced by extensive corrosion, scale, and other deterioration of wall thicknesses; pipe movement, misalignment, nonuniform slope; joint separation; and other indications of failure, or evidence of exposure to freezing temperatures, excessive thermal expansion and contraction, and fire damage.

Solution. Removal or repair of the damaged parts.

Discussion. Age alone is not indicative of the condition of a plumbing drainage system. Many systems have been found to be in excellent physical condition after decades of services.

1.2
Problem. Reduction of clearances in sleaves and supports, pipe deflection, or other evidence, indicates that the DWV system has been subjected to live or dead loads.

Solution. Remove such live or dead loads and repair or replace damaged parts.

B. HYDRAULIC INTEGRITY

Identifying Existing Conditions

(a) If the existing DWV system appears to be watertight and in sound condition, consider performing no tests for hydraulic integrity.

(b) If visual inspection leaves some doubt as to the hydraulic integrity of the DWV system, perform the following system test, if possible:

Finished Plumbing Test. The test of the completed drainage waste and vent system should be completed by filling all traps with water and then introducing into the system, near the base of the stack, a thick pungent smoke. When the smoke appears at the vent openings, they shall be closed and a pressure equivalent to a two-inch water column attained. This pressure shall be held for 15 minutes before inspection starts.

(c) Perform the following test on a portion of the DWV system, if (b) above cannot be performed:

Flow Test. The flow test shall be completed by filling each fixture within a group to its normal capacity and then discharging the spent water. Where several fixtures are connected to the same branch, the fixtures shall be discharged together.

(d) If there is some doubt as to the general serviceability of the DWV system, perform the following test:

Rough Plumbing Test. The water or air test conducted on the roughed in plumbing shall be completed by blocking the lower portion of the system and filling the drainage and vent piping with water. In tall buildings the system should be tested at intervals such that the manufacturer's working pressure for the joints is not exceeded, but no section should be tested with less than 10 feet of water except the uppermost 10 feet of the system. The water shall be kept in the system for at least 15 minutes before the inspection starts. The system shall be tight at all points. When using air as a test media, all inlets and outlets must be sealed except where the air pressure apparatus is connected to the system. Air shall be forced in until a uniform gauge pressure of 5 psi is attained. This pressure shall be held for 15 minutes without the introduction of additional air.

Problem and Proposed Solution

1.3
Problem. The entire DWV system is not leak tight when tested by methods (a) and/or (b) above, or the major elements of the DWV system are not leak tight when subjected to a pressure of 5 psi, by method (d) above.

Solution. Repair or remove parts of the DWV system as needed to bring it to a condition of leak-tightness under the subject tests.

C. FUNCTIONAL PERFORMANCE

Identifying Existing Conditions

DWV systems with proven hydraulic integrity (see B above), should be subjected to the following clear water test for determining resistance to induced siphonage and blowback:

(a) Select the required test load from the table below. The fixtures selected for discharge shall be those most remote with respect to the building drain in single family homes, and vertically adjacent at the uppermost levels in multi-family dwellings.

Building Type	Test Load
Single family residence	One water closet and one tub
Low rise multi-family up to four stories	Two water closets
High rise multi-family up to ten stories	Two water closets and one tub

(b) Fill all fixture traps. Discharge the selected fixtures simultaneously. Observe and record the trap seal loss in the idle fixture traps. Observe the lower floor waste closets for blowback.

Problem and Proposed Solutions

1.4

Problem. Trap seal loss of more than one-inch of water, and/or blowback, is observed in the DWV system.

Solution. Modify, in accordance with Part 4 of the guideline, the DWV system to a condition where it meets the above test (see also the Basic Drainage and Hydraulic Concepts section of this guideline).

Discussion. Performance tests in the laboratory on full-scale drainage systems have shown that trap seal loss by induced siphonage is greatest in those fixtures located two and three floors below the active fixtures. Blowback, the most common mode of failure, usually is observed in the ground or first floor water closets. Systems near capacity will show trap seal reduction of 3/4" to 1" and/or display considerable movement of the water surface in the closets.

2. DETERMINING THE CAPACITY OF THE EXISTING DWV SYSTEM

1) Identify and count all fixtures connected to each DWV stack. Translate the fixture count into fixture unit values, based on the following table:

Fixture	Fixture Units
Automatic washers	3
Bathtub (w/ or w/o overhead shower)	2
Bathroom group	6
Dishwasher	2
Floor drain	2
Kitchen sink, w/ or w/o food-waste grinder	2
Lavatory	1
Laundry tray	2
Shower stall	2
Sink, service type w/ floor outlet trap stan.	3
Sink, service type with P-trap	2
Water closet	4

2) Identify the size of the stack and size and slope of the drain.

3) Determine the extent of venting (i.e., single stack with no vents, vents of unknown condition, or code-compliant vents).

4) Based on (2) and (3) above, estimate the fixture unit capacity of the DWV system from the following table:

Stack size	Building Drain size @ ¼" slope* per foot	Single stack (no vents)	Vents of unknown condition	Code compliant vents
3"	4"	15**	30**	72**
4"	4"			
4"	5"		150	216
5"	5"	ALLOWABLE		480
5"	6"	FIXTURE UNITS		480
				840

* if flope exceeds ¼" per foot, capacity will increase
** not more than 3 stories, nor more than 6 water closets

Note: Data for the above table was prepared by the Davidson Laboratory, Stevens Institute of Technology

3. RELOCATING FIXTURES

Identifying Existing Conditions

1. Determine the new location of the desired fixture(s).
2. Determine the location of the vertical drain that services the new fixture(s).
3. Use the following table to determine if the proposed length of the fixture drain exceeds the maximum allowed.

Maximum Length of Fixture Drains

Diameter of Drain	Length
1¼"	5'
1½"	7'
2"	10'
3"	12'
4"	20'

Problem and Proposed Solution

3.1
Problem. The length of the fixture drains for the fixture to be relocated exceeds that allowed by the local plumbing code.

Solution. Allow fixture drain lengths up to the maximum indicated in the above table.

Discussion. The concern for self-siphonage in fixtures has led to limitations on lengths of fixture drains. Existing distances as specified in codes impose a severe restriction on rehabilitation. The smaller diameter fixture outlets of modern installations have reduced flow rates and suggest longer permissible fixture drains. The above recommended distances have been developed by the Davidson Laboratory, Stevens Institute of Technology.

3.2
Problem. An S trap that is prohibited by the local plumbing code exists in a building to be rehabilitated.

Solution. Allow modification of the fixture so that the distance between the trap outlet and the vertical drop is at least two pipe diameters but only if the size of the vertical pipe is one diameter larger than the trap inlet.

Discussion. The concern for self-siphonage common to S traps has led to their prohibition by codes. Self-siphonage in S traps can be eliminated by the modification described above.

4. ADDING NEW FIXTURES TO EXISTING DWV SYSTEMS, EXTENDING DWV SYSTEMS, AND INSTALLING NEW DWV SYSTEMS IN EXISTING BUILDINGS

Identifying Existing Conditions

Determine the structural, hydraulic, and functional performance of the existing DWV system as in Part 1 of these Guidelines. Determine the capacity of the existing DWV system as in Part 2 of this guideline.

Problem and Proposed Solutions

4.1
Problem. Full compliance with existing plumbing codes in adding to or altering existing plumbing DWV systems may lead to unintended structural or other changes that result in unwarranted additional costs and delays to rehabilitation projects.

Solution. All additions and alterations to existing plumbing DWV systems should be designed and installed in accordance with the following performance specifications.

1) Transport of Wastes

Requirement. Waste water and sewage should be removed from the building and transported to an acceptable point of disposal without overflowing, accumulating, or backing up into fixtures.

Criteria.

a) Drainage stacks shall carry design loads when flowing less than 1/3 full at terminal velocity.

b) Horizontal sanitary drains, except horizontal fixture drains, should flow no more than approximately ½ full under design loads. Horizontal fixture drains should be sized to give an optimum balance between scouring velocity, diameter, and carrying capacity.

c) Maximum lengths of fixture drains are as follows:

Diameter of Drain	Length
1¼"	5'
1½"	7'
2"	10'
3"	12'
4"	20'

d) Waste lines (especially kitchen lines of 2" diameter or less) should not pass through unheated spaces, or be located within or adjacent to outside walls.

e) Vents should not connect to horizontal drains unless the bases of such vent connections are washed by the discharge from one or more small fixtures.

f) Provide a uniform, continuous grade of the invert of horizontal drain lines.

g) Fittings, devices, connections, and methods of installation should not obstruct or retard the normal flow of fluids in soil, waste or vent lines.

h) Waste water or waterborne solids from an active drain pipe shall not pass through an idle trap to a fixture.

i) Suitable means should be provided for handling drainage below sewer level. Drainage from parts of drainage systems which cannot drain by gravity into the sewer should be disposed of through subbuilding drainage systems and discharged into the building gravity drainage system by automatic equipment or by another approved method.

Test. Determination of conformance to criteria by evaluation of calculations, plans, and specifications, inspection of built elements, and conformance to good engineering and trade practices.

Discussion. These criteria have been derived from experience and research on plumbing hydraulics at the Davidson Laboratory, Stevens Institute of Technology, or from standard design practice.

2) Durability.

Requirement. The plumbing DWV system and its parts should have a reasonable life expectancy.

Criteria.

a) New plumbing DWV equipment and systems should be made of materials approved for new construction materials, free from defective workmanship, and designed and installed so as to be durable, without need for frequent repairs or major replacements.

b) Before proceeding with an installation, the installer should consult with the local Building Department to determine the durability of materials and joints used under local conditions.

c) The installer should observe the manufacturer's good practice recommendations regarding care, installation, and adjustment of equipment so that the performance of such products will not be impaired by defects or damage during installation, or by poor installation practices.

Test. Determination of conformance to criteria by inspection of installation and materials, and conformance to good trade practices.

3) Maintainability.

Requirement. The design and installation of the drainage system should provide for cleaning, servicing, adjusting, or replacing the various elements, and should minimize conditions that contribute to soiling, deposition, fouling, clogging, or other maintenance problems.

Criteria.

a) Horizontal drains shall be installed in uniform alignment at a slope in the direction of flow of at least 1/4 inch per foot for diameters of 4 inches and greater, to obtain self-scouring velocities. Where such slopes are not attainable, lesser slopes may be used if a mean velocity of at least 2 feet per second can be computed for open channel steady flow at an assumed depth equal to 1/2 of the diameter.

b) Access to permit convenient removal of obstructions and fouling matter in horizontal drain lines should be provided not more than 100 feet apart for larger pipes; at each change of direction of the building drain in excess of 45°; at or near the foot of each vertical soil or waste stack; and near the junction of the building drain and building sewer.

Test. Determination of conformance to criteria by evaluation of calculations, plans, and specifications, inspection of built elements, and conformance to good engineering and trade practices.

4) Structural Serviceability.

Requirement. The drainage waste and vent system should be capable of withstanding the physical forces that may reasonably be expected in the building during the rehabilitation process and in subsequent use.

Criteria.

a) The mechanical strength of new pipe, fittings, and supports should be similar to that of new construction.

b) The drainage, waste, and vent system should be securely attached to the building.

c) Drainage, waste, and vent piping shall not be subject to dead or live loads at any time.

Test. Evaluation of installation.

5) Hydraulic Integrity.

Requirement. The drainage, waste, and vent system should be air and water tight under conditions of normal use.

Criteria.

a) Rough Plumbing Test. The major elements of the drainage waste and vent system, building drains, stacks and horizontal branches shall be leak tight when subjected to a pressure of 5 psi.

b) Finished Plumbing Test. The completed drainage waste and vent system shall be leak tight when subjected to a pressure equivalent to a 2-inch water column.

Test.

a) Rough Plumbing Test. The water or air test conducted on the roughed in plumbing shall be completed by blocking the lower portion of the system and filling the drainage and vent piping with water. In tall buildings the system should be tested at intervals such that the manufacturer's working pressure for the joints is not exceeded but no section should be tested with less than 10 feet of water except the uppermost 10 feet of the system. The water shall be kept in the system for at least 15 minutes before the inspection starts. The system shall be tight at all points.

When using air as the test media, all inlets and outlets must be sealed except where the air pressure apparatus is connected to the system. Air shall be forced in until a uniform gauge pressure of 5 psi is attained. This pressure shall be held for 15 minutes without the introduction of additional air.

b) Finished Plumbing Test. The test of the completed drainage waste and vent system shall be completed by filling all traps with water and then introducing into the system near the base of the stack a thick pungent smoke. When the smoke appears at the vent openings, they shall be closed and a pressure equivalent to a 2-inch water column attained. This pressure shall be held for 15 minutes before inspection starts.

6) Functional Performance.

Requirement. The drainage, waste and vent system should accept and transport spent water and liquid in a safe and efficient manner.

Criterion. The drainage, waste and vent system shall not, under conditions of normal use, emit sewer gas and foul air, or eject suds or liquids inside the building.

Test. A clear-water test for determining resistance to induced siphonage and blowback shall be conducted on a pressure tight system.

a) Select the required test load from the table below. Fixtures selected for discharge shall be those most remote with respect to the building drain in single family homes, and vertically adjacent at the uppermost levels in multi-family dwellings.

Building Type	Test Load
Single Family Residence	One water closet and one tub
Low Rise multi-family up to 4 stories	Two water closets
High rise multi-family up to 10 stories	Two water closets and one tub

b) Fill all fixture traps. Discharge the selected fixtures simultaneously. Observe and record the trap seal loss in the idle fixture traps. Observe the lower floor water closets for blowback.

c) Trap seal loss greater than one inch, or evidence of blowback, should be the basis for rejection.

Commentary. Performance tests in the laboratory on full-scale drainage systems have shown that trap seal loss by induced siphonage is greatest in those fixtures located two and three floors below the active fixtures. Blowback, the most common mode of failure, usually is observed in the ground or first floor water closets. Systems near capacity will show trap seal reduction of 3/4"-1" and/or display considerable movement of the water surface in the closets.

7) Surcharged Sewers.

Requirement. Sewage should not enter the building from public sewer systems.

Criterion. Where the drainage system of a building is subject to backflow from the public sewer system, suitable means should be employed to prevent such backflow from entering the building.

Test. Evaluation of installation.

Discussion. The overflow of sewage in buildings from backflow effects is a serious malfunction of plumbing and sewerage systems, and should be remedied during the rehabilitation process, if required.

The Appendix to this guideline illustrates acceptable practices that comply with the above performance specifications for additions and alterations to existing plumbing DWV systems in rehabilitation projects.

5. THROUGH-THE-WALL VENTING

Identifying Existing Condition

An existing DWV system, an addition to an existing DWV system, or a new DWV system in an existing building, may include through-the-wall rather than roof venting. This condition may be determined by inspecting the building or examining existing and/or proposed plans.

Problem and Solution

5.1

Problem. Through-the-wall venting, usually prohibited by codes, exists or is proposed in an existing building to be rehabilitated.

Solution. Accept through-the-wall venting in the following instances:

(a) In historic building where through-roof venting would interfere with the character of the building.

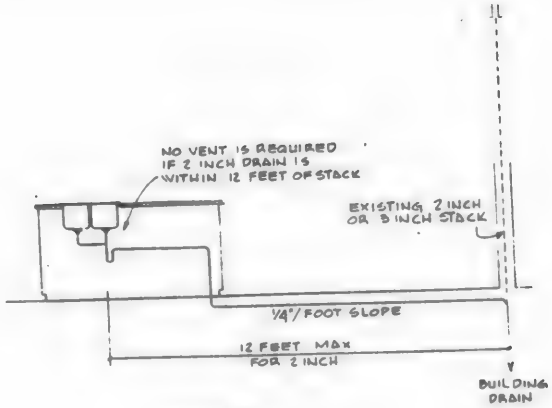
(b) In rehabilitation projects where conventional venting is impractical. In this case, the vents should be at least ten feet horizontally from the lot line and should be turned downward. They should be effectively screened, not be located directly below any door, window or other building opening, nor should any such vent terminal be within ten feet horizontally of such an opening unless it is two feet above the top of such opening. Vent terminals shall not terminate under the overhang of a building.

APPENDIX

EXAMPLES OF ACCEPTABLE DWV PRACTICES FOR BUILDING REHABILITATION

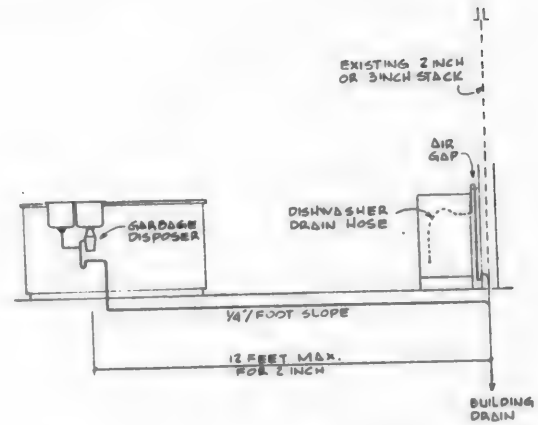
Symbols

WC	water closet
T	bathtub
L	lavatory
KS	kitchen sink
———	new sanitary piping
———	existing sanitary piping
- - - - -	vents


NO VENT IS REQUIRED IF 2 INCH DRAIN IS WITHIN 12 FEET OF STACK
EXISTING 2 INCH OR 3 INCH STACK
1/4"/FOOT SLOPE
12 FEET MAX FOR 2 INCH
BUILDING DRAIN

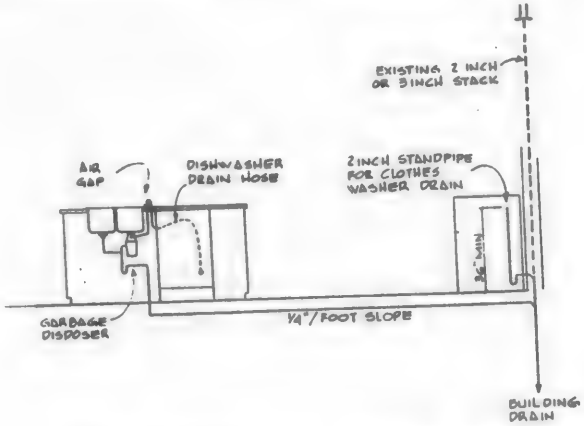
ISLAND SINK

Single Family Dwelling



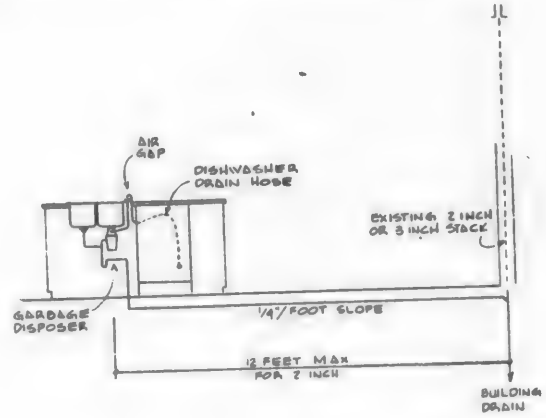
ISLAND SINK WITH DISPOSER AND DISHWASHER AT WALL

Single Family Dwelling



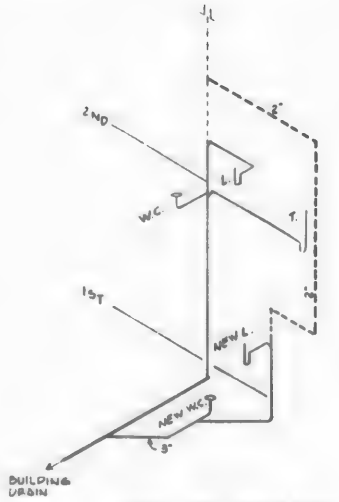
ISLAND SINK WITH DISPOSED, DISHWASHER, AND CLOTHES WASHER AT WALL

Single Family Dwelling



ISLAND SINK WITH DISPOSER AND DISHWASHER

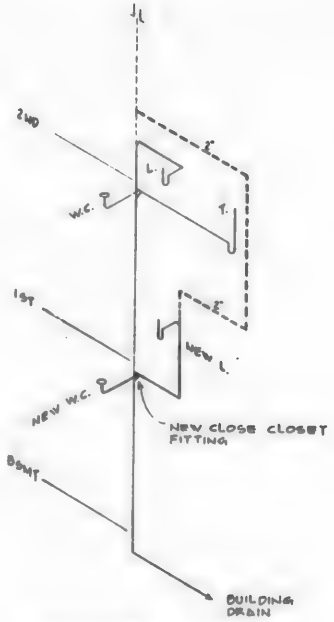
Single Family Dwelling



NOTE: NEW BRANCH DRAIN LINE MAY ENTER BUILDING DRAIN ON STACK.

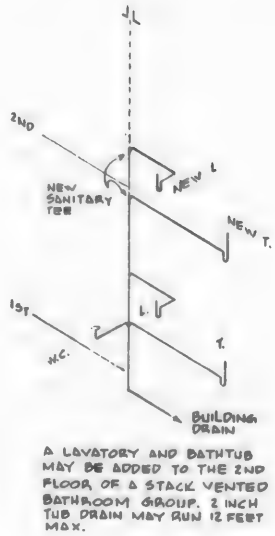
ADDITION OF FIRST FLOOR POWDER ROOM

Single Family Dwelling, Slab on Grade

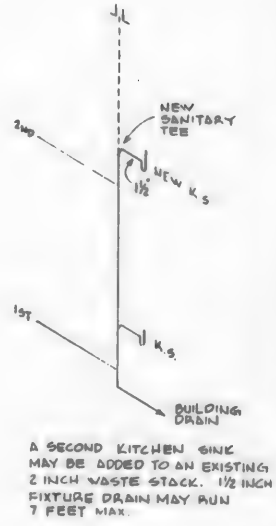


ADDITION OF FIRST FLOOR POWDER ROOM

Single Family Dwelling, with Basement



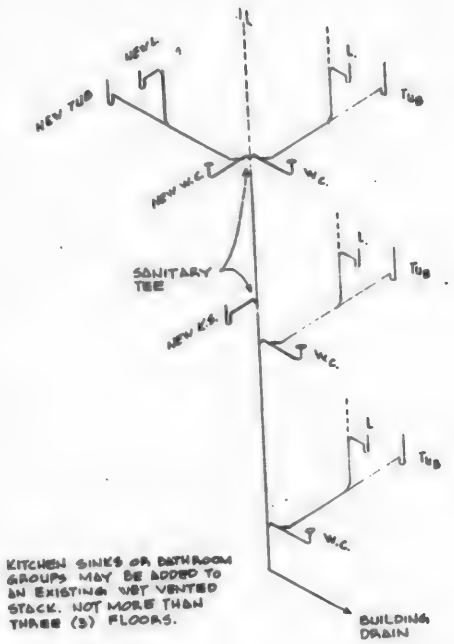
A LAVATORY AND BATHTUB MAY BE ADDED TO THE 2ND FLOOR OF A STACK VENTED BATHROOM GROUP. 2 INCH TUB DRAIN MAY RUN 12 FEET MAX.



A SECOND KITCHEN SINK MAY BE ADDED TO AN EXISTING 2 INCH WASTE STACK. 1½ INCH FIXTURE DRAIN MAY RUN 7 FEET MAX.

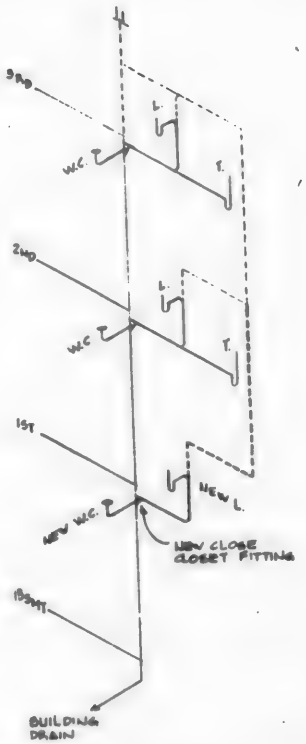
ADDITIONS TO SECOND FLOOR FIXTURES TO EXISTING STACKS

Single Family Dwelling, Slab on Grade



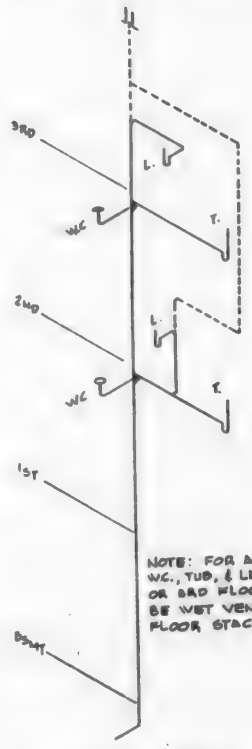
ADDITION OF KITCHEN SINK AND BATHROOM GROUP

Two Family Townhouse



ADDITION OF FIRST FLOOR POWDER ROOM

Two Family Townhouse

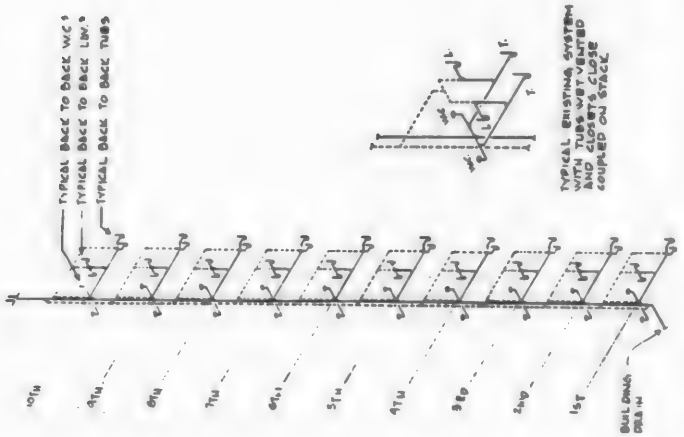


ADDITION OF SECOND OR THIRD FLOOR BATHROOM GROUP

Two Family Townhouse

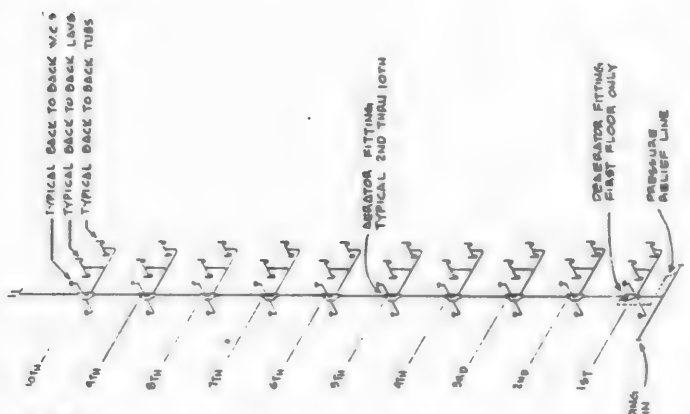
ADDITION OF DISPOSER AND DISHWASHER TO KITCHEN SINK

Multi-Family High Rise



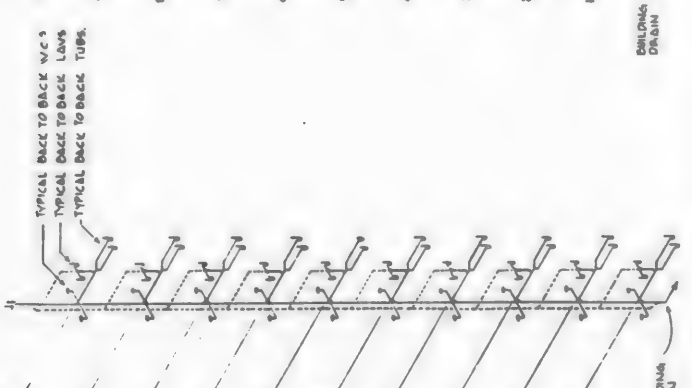
TYPICAL EXISTING VENTED SYSTEM WITH ALTERNATE

Multi-Family High Rise



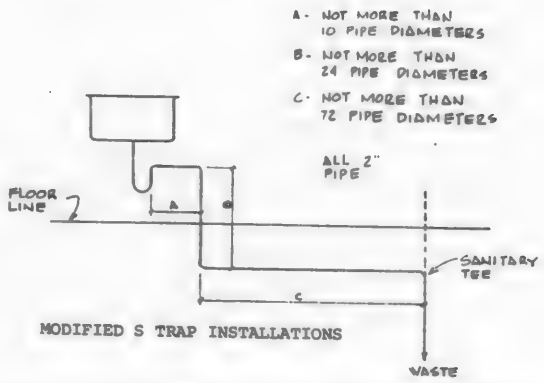
SINGLE STACK SYSTEM

Multi-Family Highrise

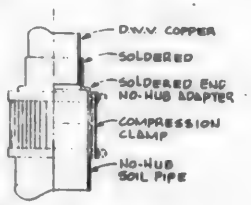


WET VENTING OF TUBS AND WATERCLOSETS

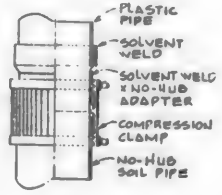
Multi-Family Highrise



MODIFIED S TRAP INSTALLATIONS



COPPER TO NO-HUB C.I.



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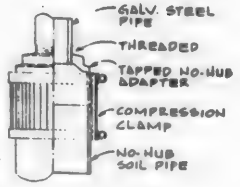
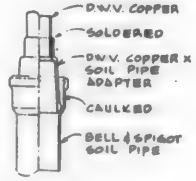
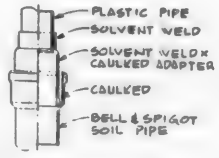


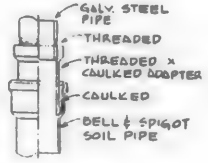
GALV. PIPE TO NO-HUB C.I.



COPPER TO BELL SPIGOT C.I.



PLASTIC TO BELL & SPIGOT C.I.



GALV. TO BELL & SPIGOT C.I.

TYPICAL CONNECTION DETAILS

Volume 3
Rehabilitation Guidelines

GUIDELINE ON FIRE RATINGS OF ARCAHIC MATERIALS AND ASSEMBLIES

FOREWORD

Section 903 of the Housing and Community Development Amendments of 1978 (Public Law 95-557, enacted October 31, 1978) requires that the Secretary of the Department of Housing and Urban Development:

> *"develop model rehabilitation guidelines for the voluntary adoption by States and communities to be used in conjunction with existing building codes by State and local officials in the inspection and approval of rehabilitated properties."*

Section 903 of the Amendments was predicated in part by the March 24, 1978 hearing on the "Impact of Building Codes on Housing Rehabilitation," held by the Senate Committee on Banking, Housing, and Urban Affairs. The hearing highlighted the many code-related problems that arise during the rehabilitation of the nation's existing building stock. Hearing testimony indicated that a significant cause of these problems was that existing codes and code enforcement techniques are primarily designed for new construction, and contain neither the administrative, legal, or technical mechanisms to properly deal with rehabilitation.

Section 903 of the Amendments also requires that the Secretary of the Department of Housing and Urban Development shall:

> *"publish such guidelines for public comment not later than one year after the enactment of this section, and promulgate them no later than eighteen months after such date of enactment."*

Accordingly, the following draft documents have been prepared for public comment:

Rehabilitation Guidelines, Volume 1
Administrative and Legal Guidelines for Building Rehabilitation

Rehabilitation Guidelines, Volume 2
Technical Guidelines for Residential Rehabilitation

Rehabilitation Guidelines, Volume 3
Guideline on Fire Ratings of Archaic Materials and Assemblies

The intent of these guidelines is to reduce, while maintaining essential levels of health and safety, those regulatory requirements that create unnecessary constraints, time delays, and higher costs for building rehabilitation.

Volume 1, Administrative and Legal Guidelines for Building Rehabilitation, is designed for use by building officials, members of the legislative and executive branches of State and local governments, and related commissions and organizations that are involved in developing or implementing building regulations. Volume 1 covers the following topics:

- The Guideline for Setting and Adopting Standards for Building Rehabilitation provides an introduction and background to the building regulations that affect rehabilitation. It shows methods for identifying existing regulatory conditions in a community and lists recommendations for amending or modifying the community's regulatory system to encourage rehabilitation.
- The Guideline for Municipal Approval of Building Rehabilitation outlines a model submittal, review, and approval process for rehabilitation that is recommended for adoption by municipal building departments.
- The Statutory Guideline for Building Rehabilitation provides recommendations for statutorily modifying existing code decision making systems with the express goal of promoting rehabilitation.
- The Guideline for Managing Official Liability Associated with Building Rehabilitation addresses the liability of code officials involved with the regulation and enforcement of building rehabilitation, and provides recommendations for minimizing liability problems.

Volume 2, Technical Guidelines for Residential Rehabilitation, is intended for use by code inspectors, designers, and builders involved in residential rehabilitation. Volume 2 covers the following topics:

- The Egress Guideline for Residential Rehabilitation lists design alternatives for the components of egress that are regulated by current codes: number of exits, corridors and stairs, arrangement of exits, travel distance, dead-end travel, and exit capacity and width.
- The Electrical Guideline for Residential Rehabilitation discusses the establishment of standards for electrical rehabilitation, gives procedures for conducting inspections of electrical systems, and presents problems and solutions associated with electrical rehabilitation.
- The Plumbing DWV Guideline for Residential Rehabilitation includes a background discussion of basic drainage and hydraulic concepts, followed by criteria to determine the condition and capacity of existing DWV (drainage, waste, and vent) systems. Methods and criteria are presented for relocating fixtures, adding new fixtures to existing DWV systems, extending existing DWV systems, and installing new DWV systems in existing buildings. Through-the-wall venting is also discussed.

Volume 3, Fire Ratings of Archaic Materials and Assemblies, is intended for use by code officials and designers in determining the fire ratings of building materials and assemblies that are no longer listed in current building codes or related reference standards. Extensive entries are provided for the fire ratings of walls, columns, floors and ceilings. Introductory material discusses flame spread, the effects of penetrations, and methods for determining the ratings of assemblies not listed in the guideline.

The draft rehabilitation guidelines were prepared by the National Institute of Building Sciences under contract to the Department of Housing and Urban Development. Issues addressed in the guidelines were selected from a March, 1978 study by the Institute entitled "Code-Related Rehabilitation Problems: Problem Identification/Verification/Feasibility Report," which identified approximately fifty code-related problems and determined that eighteen of these problems were feasible to address within the state-of-the-arts and within the legislated time constraints. Actual problem selection was made by a committee formed by the Institute under the legislative mandate that:

> *"such guidelines shall be developed in consultation with.....appropriate national organizations of agencies and officials of State and local governments, representatives of the building industry, and consumer groups, and other interested parties."*

The committee formed by the Institute was composed of representatives of the following organizations:

- Council of American Building Officials
- National Conference of States on Building Codes and Standards
- National Fire Protection Association
- American Institute of Architects
- Building Code Action
- National Home Improvement Council
- National Housing Rehabilitation Association
- National Association of Home Builders
- AFL-CIO Building and Construction Trades Department
- Association of Major City Building Officials
- U.S. Conference of Mayors
- National League of Cities
- National Trust for Historic Preservation
- U.S. League of Savings Associations
- National Association of Housing and Redevelopment Officials

Major subcontractors used by the Institute for addressing the selected problems included:

- Building Technology, Inc.
- Joseph Stein
- Davidson Laboratory, Stevens Institute of Technology
- Council of American Building Officials
- J. Bradford Corporation
- National Fire Protection Association
- Arthur D. Little, Inc.
- National Conference of States on Building Codes and Standards
- Vincent Brannigan, Esq.

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INTRODUCTION

The Guideline on Fire Ratings of Archaic Materials and Assemblies focuses upon the fire-related performance of archaic construction. "Archaic" encompasses construction typical of an earlier time, generally prior to 1950. "Fire-related performance" includes fire resistance, flame spread, smoke production and degree of combustibility.

The purpose of this Guideline is to update the information which was available at the time of original construction, for use by architects, engineers, and code officials when evaluating the fire safety of a rehabilitation project. The local origin of many archaic materials means that there may never have been any fire test information available about the particular material of a given project. A perspective and framework for the evaluation of general classes of materials and types of construction is presented for these cases.

It has been assumed that the building materials and their fastening, joining, and incorporation into the building structure are sound mechanically. Therefore, some determination must be made that the original manufacture, the original construction practice, and the rigors of aging and use have not weakened the building. This assessment can often be difficult because process control was not good in many industries, and variations among locally available raw materials and manufacturing techniques often resulted in a product which varied widely in its strength and durability. The properties of iron and steel, for example, varied widely, depending on the mill and the process used.

There is nothing inherently inferior about archaic materials or construction techniques. The pressures that promote fundamental change are most often economic or technological -- matters unrelated to concerns for safety. The high cost of labor made wood lath and plaster uneconomical. The high cost of land and the congestion of the cities provided the impetus for high-rise construction. Improved technology made it possible. The difficulty with archaic materials is not a question of suitability, but familiarity.

Code requirements for the fire resistance of key building elements (e.g., walls, floor/ceiling assemblies, doors, shaft enclosures) are stated in performance terms: hours of fire resistance. It matters not whether these elements were built in 1909 or 1979, only that the required degree of fire resistance be provided.

Building officials will generally require that the fire resistance of these key building elements be documented. This documentation is widely available for current materials and assemblies: manufacturers provide test data to encourage the use of their products and designs; some codes contain tables listing approved designs; independent testing laboratories publish indices of test results.

The problem with archaic materials is simply that documentation of their fire performance is not readily available. The application of engineering judgment is more difficult because building officials are often not familiar with the materials or construction method involved. As a result, either a full-scale fire test will be required or the archaic construction in question removed and replaced. Both alternatives are time consuming and wasteful.

This Guideline and the accompanying Appendix are designed to help fill this information void. By providing the necessary documentation, there will be a firm basis for the continued acceptance of existing archaic materials and assemblies.

SECTION I

FIRE-RELATED PERFORMANCE OF ARCHAIC MATERIALS AND ASSEMBLIES

A. Fire Performance Measures

This Guideline does not specify what level of performance will be required for the various building components. These requirements will depend upon the building occupancy and use, and are normally set forth in the building code.

The fire resistance of a given building element is established by subjecting a sample of the assembly to a "standard" fire test which follows a "standard" time temperature curve. This test method has changed little since the 1920's. The test results tabularized in the Appendix have been adjusted to reflect current test methods.

The current model building codes cite other fire-related properties not always tested for in earlier years: flame spread, smoke production, and degree of combustibility. However, they can generally be assumed to fall within well defined values since the principal combustible component of archaic materials is cellulose. The first flame spread fire tests were just being developed around the early 1940's. Though smoke production is more important today because of the increased use of plastics, the early flame spread tests also included a test for smoke production.

"Plastics", one of the most important classes of contemporary materials, were not found in the review of archaic materials. If plastics are to be used in a rehabilitated building, they should be evaluated by contemporary standards. Information and documentation of their fire-related properties and performance is widely available.

Flame spread, smoke production and degree of combustibility are discussed in detail below. Test results for eight common species of lumber are noted in the following Table:

TUNNEL TEST RESULTS FOR EIGHT SPECIES OF LUMBER (104)

Species of Lumber	Flame Spread	Fuel Contributed	Smoke Developed
Western White Pine	75	50-60	50
Northern White Pine	120-215	120-140	60-65
Ponderosa Pine	180-215	120-135	100-110
Yellow Pine	180-190	130-145	275-305
Red Gum	140-155	125-175	40-60
Yellow Birch	105-110	100-105	45-65
Douglas Fir	65-100	50-80	10-100
Western Hemlock	60-75	40-65	40-120

Flame Spread

The flame spread of interior finishes is usually measured by the ASTM E-84 "tunnel test". The most commonly used flame spread classifications (FSC) are: Class I or A*, with a 0-25 FSC; Class II or B, with a 26-75 FSC; and Class III or C, with a 76-200 FSC. The NFPA Life Safety Code also has a Class D (201-500 FSC) and Class E (over 500 FSC) interior finish. These classifications are typically used in modern building codes to restrict the rate of fire spread. Only the first three classifications are normally permitted.

In general, inorganic archaic materials (e.g., bricks or tile) can be expected to be in Class I. Materials of whole wood are mostly Class II. Whole wood is defined as wood used in the same form as sawn from the tree. This is in contrast to the contemporary reconstituted wood products such as plywood, fiberboard, hardboard or particle board. If the organic archaic material is not whole wood, the flame spread classification could be well over 200 and thus would be particularly unsuited for use in exitways and other critical locations in a building. Some plywoods and various wood fiberboards may have flame spreads over 200. Although they can be treated with fire retardants to reduce their flame spread, it would be advisable to assume that all such products have a flame spread over 200 unless there is information to the contrary.

* Some codes use roman numerals, others use letters.

Smoke Production

The evaluation of smoke density is part of the ASTM E-84 tunnel test. For the eight species of lumber shown in the table above, the highest levels are 275-305 for Yellow Pine, but the others are less smoky than the red oak which has an index of 100. The advent of plastics caused substantial increases in the smoke density values measured by the tunnel test. The ensuing limitation of the smoke production for wall and ceiling materials by the model building codes has been a reaction to the introduction of plastic materials. In general, cellulosic materials fall in the 50-300 range of smoke density which is below the general limitation of 450 adopted by many codes.

Degree of Combustibility

There has been a tendency by the model building codes to define "noncombustibility" on the basis of having passed ASTM E-136 or if the material is totally inorganic. The acceptance of gypsum wallboard as noncombustible is based on limiting paper thickness to 1/8" and 0-50 flame spread classification (FSC) by ASTM E-84. At times there were provisions to define a Class I or A material (0-25 FSC) as noncombustible, but this is not currently recognized by most model building codes.

If there is any doubt whether or not an archaic material is noncombustible, it would be appropriate to send out samples for evaluation by ASTM E-136. If an archaic material is determined to be noncombustible by ASTM E-136, it can be expected that it will not contribute fuel to the fire.

B. Combustible Construction Types

One of the earliest forms of timber construction utilized exterior load-bearing masonry walls with columns and/or wooden walls supporting wooden beams and floors in the interior of the building. This form of construction, often called "mill" or "heavy timber" construction, has approximately 1-hour fire resistance. The exterior walls will generally contain the fire within the building.

As population pressure increased and more lumber became available, there was a switch from heavy timber to "balloon frame" construction. The balloon frame uses load-bearing exterior wooden walls which have long timbers often extending from foundation to roof. When longer lumber became scarce, another form of construction, "platform" framing, replaced the balloon framing. The difference between the two systems is significant because platform framing is automatically fire-blocked at every floor while balloon framing commonly has concealed spaces that extend unblocked from basement to attic. The architect, engineer, and code official must be alert to the details of construction and the ease with which fire can spread in concealed spaces.

SECTION II

BUILDING EVALUATION

A given rehabilitation project will most likely go through several stages. The preliminary evaluation process involves the designer in surveying the prospective building. The fire resistance of existing building materials and construction systems are identified; potential problems are noted for closer study. The final evaluation phase includes: developing design solutions to upgrade the fire resistance of building elements, if necessary; the preparation of working drawings and specifications; and the securing of the necessary code approvals.

A. Preliminary Evaluation

A preliminary evaluation should firstly consist of a building survey to determine the existing materials, the general arrangement of the structure, the use of the occupied space, and the details of construction. The designer needs to know "what is there" before a decision can be reached about what to keep and what to remove in the rehabilitation process. This preliminary evaluation should be as detailed as necessary to make initial plans. The fire-related properties need to be determined from the applicable building code, and the existent materials and assemblies in the building then need to be evaluated for these properties. Two work sheets are introduced below to facilitate the preliminary evaluation.

Table A is a suggested work sheet for the preliminary field notes. This work sheet lists the materials, thickness, and condition for each of the principal building elements. In addition to Table A, the field investigator should prepare a schematic diagram showing the exit system for the building and to indicate where each element from Table A fits into the structure as a whole. Each floor of the structure should be visited and the information in Table A completed. In practice, there will often be identical materials and construction on each floor, but the exception to this rule may be of vital importance. A drawing should be prepared of each floor showing the layout of exits and hallways. The exact arrangement of interior walls within apartments or offices is of secondary importance from a fire safety point of view and need not be shown on the drawings unless these walls are required by the building code to have a fire resistance rating.

The location of stairways and elevators should be clearly marked on the drawings. If exterior steel "fire escapes" are present, they should be identified even though they are no longer favored for exiting purposes.

The following notes explain the entries in Table A:

(i) Exterior Bearing Walls: Many old buildings utilize heavily constructed walls to support the floor/ceiling assemblies at the exterior of the building. There may be columns and/or interior bearing walls within the structure, but these exterior walls are an important

TABLE A

PRELIMINARY EVALUATION

FIELD NOTES

Building Element		Materials	Dimension	Condition	Notes
Exterior Bearing Walls					
Interior Bearing Walls					
Exterior Non-Bearing Walls					
Interior Non-Bearing Walls or Partitions:	A				
	B				
Structural Frame:	Columns				
	Beams				
	Other				
Floor/Ceiling Structural System Spanning					
Roofs					
Doors (including frame and hardware):					
a) Enclosed vertical exitway					
b) Enclosed horizontal exitway					
c) Other					

factor in assessing the fire safety of a building. The field investigator should note how the floor/ceiling assemblies are supported at the exterior of the building. If columns are incorporated in the exterior walls, the walls may be considered non-bearing.

(ii) Interior Bearing Walls: It may be difficult to determine whether or not an interior wall is load bearing, but the field investigator should attempt to make this determination. At a later stage of the rehabilitation process, this question will need to be determined exactly. Nevertheless, the field notes should be as accurate as possible.

(iii) Exterior Non-Bearing Walls: The fire resistance of the exterior walls is important for two reasons. These walls (both bearing and non-bearing) are depended upon to contain a fire: a) within the building; or b) keep an exterior fire outside the building. It is therefore important to indicate on the drawings where any openings are located as well as the nature of all doors or shutters. The drawings should indicate the presence of wired glass and identify the materials used for windows and door frames. The ground floor drawing should locate the building on the property and indicate the precise distances to adjacent buildings.

(iv) Interior Non-Bearing Walls or Partitions: A partition is a "wall that extends from floor to ceiling and subdivides space within any story of a building." (48) Table A has two categories (A & B) for Interior Non-Bearing Walls or Partitions which can be used for different walls, such as hallway walls as compared to inter-apartment walls. Under some circumstances there may be only one type of wall construction; in others, three or more types of wall construction may occur.

The field investigator should be on the alert for differences in function as well as in materials and construction details. As with the layout in general, the details within apartments or offices are not as important as the major exit passages and stairwells. The preliminary field investigation should attempt to determine the thickness of all walls. A term introduced below called "thickness design" will depend on an accurate (+ 1/4") determination. Even though this initial field survey is called "preliminary," the data generated should be as accurate and complete as possible.

The field investigator should note the exact location from which his or her observations are recorded. For instance, if a hole is found through a stairwell wall which allows a cataloguing of the construction details, the field investigation notes should reflect the location of the "find". At the preliminary stage it is not necessary to core every wall, though the interior details of construction can usually be determined at some location.

(v) Structural Frame: There may or may not be a complete skeletal frame, but usually there are columns, beams, trusses, or other elements. The field investigator's task is to locate a place where the dimensions can be measured. These should be indicated on the drawing. For instance, if there are ten inch square columns located on a thirty foot square grid throughout the building, this should be noted. The structural material and cover or protective materials should be identified wherever possible. The thickness of the cover materials should be determined to an accuracy of ± 1/4". As discussed above, the preliminary field survey usually relies on accidental openings in the cover materials rather than a systematic coring technique.

(vi) Floor/Ceiling Structural Systems: The span between supports should be measured. If possible, a sketch of the cross-section of the system should be made. If there is no location where accidental damage has opened the floor/ceiling construction to visual inspection, it is necessary to make such an opening. An evaluation of the fire resistance of a floor/ceiling assembly requires detailed knowledge of the materials and their arrangement. Special attention should be paid to the cover on structural steel elements and the condition of suspended ceilings and similar membranes.

(vii) Roofs: The preliminary field survey of roof systems will generally focus mainly on water-tightness. However, once it is apparent that the roof is sound for ordinary use and can be retained in the rehabilitated building, it becomes necessary to evaluate its fire characteristics. The field investigator must measure the thickness and identify the types of materials which have been used. The investigator should be aware that there may be several layers of roof materials.

(viii) Doors: The doors to stairways and hallways represent some of the most important fire elements to be considered within a building. The various uses are clearly differentiated in Table A. This should aid the field investigator in making careful measurements of the thickness of door panels and in the determination of the type of core material within each type of door. The presence of a self-closure on a door should be noted and the general operation of the doors should be checked. The latch should engage with the frame, and the hinges should be in good condition. If glass is used in the doors, it should be identified as either plain glass or wired glass.

(ix) Materials: The field investigator should be able to identify ordinary building materials. In situations where an unfamiliar material is found, a sample should be obtained. This sample should measure at least 10 cubic inches so that an ASTM E-136 fire test can be conducted to determine if it is combustible.

(x) Thickness: The thickness of all materials should be measured accurately since, under certain circumstances, the fire resistance rating is very sensitive to the material thickness.

(xi) Condition: The condition of the element and the different layers of materials are important, but at the preliminary stage a subjective judgment is sufficient for this evaluation process.

(xii) Notes: The "Notes" column can be used for many purposes, but it might be a good idea to make specific references to field notes and/or drawings to complement the table.

The next step in the preliminary evaluation is to identify the required fire resistance and flame spread for each of the building elements. These are normally established by the local building code. Then, the fire performance of the existing building elements is determined. A comparison of the required and available ratings will highlight any deficiencies. Ways of either upgrading or replacing deficient construction can then be identified. A suggested work sheet for organizing this information is given below as Table B.

TABLE B

PRELIMINARY EVALUATION

WORKSHEET

Building Element	Required Fire Resistance	Required Flame Spread	Estimated Fire Resistance	Estimated Flame Spread	Possible Upgrade	Possible Equivalent Protection	Notes
Exterior Bearing Walls							
Interior Bearing Walls							
Exterior Non-Bearing Walls							
Interior Non-Bearing Walls or Partitions	A						
	B						
Structural Frame:							
Columns							
Beams							
Other							
Floor/Ceiling Structural System Spanning							
Roofs							
Doors (including frame and hardware): a) Enclosed vertical exitway							
b) Enclosed horizontal exitway							
c) Others							

B. Fire Resistance of Existing Building Elements

The fire resistance of the existing building elements can be estimated from the tables and histograms contained in the Appendix. The Tables are organized first by type of building element: walls, columns, floor/ceiling assemblies, beams, and doors and door materials. Within each building element, the Tables are organized by type of construction (e.g., masonry, metal, wood frame), and then further divided by minimum dimensions or thickness of the building element.

A histogram precedes every Table that has 10 or more entries. The X-axis measures fire resistance in hours; the Y-axis shows the number of entries in that Table having a given level of fire resistance. The histograms also contain the location of each element within that Table for easy cross-referencing.

The histograms, because they are keyed to the Tables, can speed the preliminary investigation. For example, Table 1.3.2, "Wood Frame Walls 4" to less than 6" thick", contains 96 entries. Rather than study each table entry, the histogram shows that every wall listed in that table has a fire resistance of less than 2 hours. If the building code required the wall to have a 2-hour rating, the designer, with a minimum of effort, is aware of a problem that requires closer study.

Suppose the code had only required a wall of 1-hour fire resistance. The histogram shows far fewer complying elements (19) than non-complying ones (77). If the existing element is not one of the 19 complying entries, there is a strong possibility the existing element is deficient. The histograms can also be used in the converse situation. If the existing element is not one of the smaller number of entries with a lower than required fire resistance, there is a strong possibility the existing element will be acceptable.

At some point the existing building component must be actually located within the Tables. Otherwise, the fire resistance must be determined through one of the techniques presented in Section III of the Guideline. Locating the building component not only guarantees the accuracy of the fire resistance rating, but also provides a source of documentation for the building official.

C. Effects of Penetrations in Fire Resistant Assemblies

There are often many features in existing walls or floor/ceiling assemblies which were not included in the original certification or fire testing. The most common example is pipes and utility wires passed through holes poked through the assembly. During the life of the building, many penetrations are added and by the time a building is ready for rehabilitation, it is not sufficient to just consider the fire resistance of the assembly as originally constructed. It is necessary to consider all penetrations and their impact upon fire performance. For instance, the fire resistance of corridor walls is not as important as the effect of plain glass doors or transoms. In fact, doors are the most important single class of penetrations.

A fully involved fire can have a substantial quantity of heat and excess fuel capable of penetrating any holes which might be present in the walls or ceiling of the fire compartment. In general, this leads to a severe degradation of the fire resistance of those elements and to a potential for fire spread. This is particularly applicable to penetrations located high in a compartment where the positive pressure of the fire can force the unburned gases through the penetration.

Open penetrations in a floor/ceiling assembly will generally completely negate the barrier qualities of the assembly, and will lead to rapid spread of fire to the space above. It will not be a problem, however, if the penetrations are filled with noncombustible materials strongly fastened to the structure. The upper half of walls are similar to the floor/ceiling assembly in that a positive pressure can reasonably be expected in the top of the room, and this will push hot and/or burning gases through the penetration unless it is completely sealed.

Building codes require doors installed in fire resistive walls to resist the passage of fire for a specified period of time. If the door to a fully involved room is not closed, a large plume of fire will typically escape through the doorway, preventing anyone from using the space outside the door while allowing the fire to spread. This is why door closers are so important. Glass in doors and transoms can be expected to rapidly shatter unless constructed of wire glass in a steel frame. As with other building components, penetrations or non-rated portions of doors and transoms must be upgraded or otherwise protected.

There are two Tables in Section V of the Appendix pertaining to doors. The first, Table 5.1, contains 41 entries of doors mounted in sound tight-fitting frames. Table 5.2 shows the fire resistance of the wooden door panel materials tested without the stiles and rails, the frame, or the hardware. These panels show substantially greater fire resistance than actual doors containing the same panels. This is due to flames either penetrating the cracks around the edge of the door, or, if that is blocked with intumescent paint, there are usually failures at the hinges or lock-set.

SECTION III

FINAL EVALUATION AND DESIGN SOLUTIONS

The final evaluation begins after the rehabilitation project has reached the final design stage and the choices made to keep certain archaic materials and assemblies in the rehabilitated building. The specific fire resistance and flame spread requirements are determined for the project. This may involve local building and fire officials reviewing the preliminary evaluation

as depicted on Table A, Table B, and the field drawings and notes. The final evaluation process is essentially a more refined and detailed version of the preliminary evaluation. When necessary, provisions must be made to upgrade existing building components to provide the required level of fire resistance.

This section identifies specific approaches to design solutions that can make possible the continued use of archaic materials and assemblies in the rehabilitated structure. The simplest case occurs when the materials and assembly in question are found within the Appendix Tables and the fire performance properties satisfy current code requirements. Other approaches must be used, though, if the assembly cannot be found within the Tables or the fire performance needs to be upgraded. These approaches have been grouped into two classes: experimental and theoretical.

A. The Experimental Approach

If the fire resistance rating of a material and/or assembly found in a building is not given in the Appendix Tables of this report, there are several other ways to evaluate its fire performance. One approach is to conduct the appropriate fire test(s) and thereby determine the fire-related properties directly. There are a number of laboratories in the United States which routinely conduct the various fire tests. A current list can be obtained by writing the Center for Fire Research, National Bureau of Standards, Washington, D.C. 20234.

The contract with any of these testing laboratories should include their observation of specimen preparation as well as the testing of the specimen. A complete description of where and how the specimen was obtained from the building, the transportation of the specimen, and its preparation for testing should be given in detail so that the building official can be satisfied that the fire test is representative of the actual use of the material in the building.

The test report should describe the fire test procedure and the response of the material or assembly. The laboratory usually submits a cover letter with the report to describe the provisions of the fire test that were satisfied by the material or assembly under investigation. A building official will generally require this cover letter, but will also read the report to confirm that the material or assembly complies with the code requirements. Local code officials should be involved in all phases of the testing process.

The experimental approach can be costly and time consuming because specimens must be taken from the building and transported to the testing laboratory. When a load bearing assembly has continuous reinforcement, the test specimen must be removed from the building, transported, and tested in one piece. However, when the fire performance cannot be determined by other means, there may be no alternative to a full-scale test.

A "non-standard" small-scale test can be used in special cases. Sample sizes need only be 10-25 sq. ft., while full-scale tests require test samples of either 100 or 180 sq. ft. in size. This small-scale test is best suited for testing non-load bearing assemblies against thermal transmission only.

B. The Theoretical Approach

There will be instances when certain materials and assemblies in a building undergoing rehabilitation cannot be found in the Appendix Tables. Even in those cases where test results are available for more or less similar construction, the proper classification may not be immediately apparent. Variations in dimensions, loading conditions, materials, or workmanship may markedly affect the performance of the individual building elements, and the extent of such a possible effect cannot be evaluated from the Tables.

Theoretical methods are being developed that offer an alternative to the full-scale fire tests discussed above. These techniques draw upon computer simulation and mathematical modeling, thermodynamics, heat-flow analysis, and materials science to predict the fire performance of building materials and assemblies.

Another theoretical method known as the "Ten Rules of Fire Endurance Ratings" was published by T. Z. Harmathy in the May, 1965 edition of Fire Technology. (35) Using the data from the Appendix as a base, Harmathy's Rules provide a foundation for extending the data to analyze or upgrade current as well as archaic building materials or assemblies.

HARMATHY'S TEN RULES

Rule 1: The "thermal" fire endurance of a construction consisting of a number of parallel layers is greater than the sum of the "thermal" fire endurances characteristic of the individual layers when exposed separately to fire.*

(i) The performance of an untested assembly can be estimated if the fire endurance of the individual components is known. For under this rule, the endurance of the assembly is greater than the sum of the endurance of the components. The exact rating of the assembly cannot be stated, but a minimum level of performance can be established.

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* The "thermal" fire endurance is the time at which the average temperature on the unexposed side of a construction exceeds its initial value by 250°F when the other side is exposed to the "standard" fire specified by ASTM Test Method E-119.

(ii) When a building assembly or component is found to be deficient, the fire endurance can be upgraded by providing a protective membrane. This membrane could be a new layer of brick, plaster, or drywall. The fire endurance of this membrane is called the "finish rating." Tables 1.5.1 and 1.5.2 contain the finish ratings for the most commonly employed materials. (See note (ii) to Rule 2).

(iii) The test criteria for the finish rating is the same as for the thermal fire endurance of the total assembly: average temperature increases of 250°F above ambient or 325°F above ambient at any one place with the membrane being exposed to the fire. The temperature is measured at the interface of the assembly and the protective membrane.

Rule 2: The fire endurance of a construction does not decrease with the addition of further layers.

(i) Harmathy notes that this rule is a consequence of the previous rule. Its validity also follows from the fact that, by the addition of further layers, both the resistance to heat flow and the heat capacity of the construction increase, which, in turn, reduce the rate of temperature rise at the unexposed surface.

(ii) It should also be noted that this rule is not just restricted to "thermal" performance but includes the other fire test criteria: direct flame passage, cotton waste ignition, and load bearing performance as well. This means that certain restrictions must be imposed on the materials to be added and on the loading conditions. One restriction is that a new layer, if applied to the exposed surface, must not produce additional thermal stresses in the construction, i.e., its thermal expansion characteristics must be similar to those of the adjacent layer. Each new layer must also be capable of contributing enough additional strength to the assembly to sustain the added dead load. If this requirement is not fulfilled, the allowable live load must be reduced by an amount equal to the weight of the new layer. Because of these limitations, this rule should not be applied without careful consideration of these restrictions.

Rule 3: The fire endurance of constructions containing continuous air gaps or cavities is greater than the fire endurance of similar constructions of the same weight, but containing no air gaps or cavities.

(i) By providing for voids in a construction, additional resistances are produced in the path of heat flow. Numerical heat flow analyses indicate that a 10 to 15 percent increase in fire endurance can be achieved by creating an air gap at the mid-plane of a brick wall. Since the gross volume is also increased by the presence of voids, the air gaps and cavities have a beneficial effect on stability as well. However, constructions containing combustible materials within an air gap may be regarded as exceptions to this rule because of the possible development of burning in the gap.

(ii) There are numerous examples of this rule in the Tables. For instance:

Table 1.1.4; Item W-8-M-82: Cored concrete masonry, nominal 8" thick wall with one unit in wall thickness and with 62% minimum of solid material in each unit, load bearing (80 PSI). Fire endurance is 2 1/2 hrs.

Table 1.1.5; Item W-10-M-11: Cored concrete masonry, nominal 10" thick wall with two units in wall thickness and a 2" air space, load bearing (80 PSI). The units are essentially the same as item W-8-M-82. Fire endurance is 3 1/2 hrs.

These walls show 1-hour greater fire endurance by the addition of the 2" air space.

Rule 4: The farther an air gap or cavity is located from the exposed surface, the more beneficial is its effect on the fire endurance.

(i) Radiation dominates the heat transfer across an air gap or cavity, and it is markedly higher where the temperature is higher. The air gap or cavity is thus a poor insulator if it is located in a region which attains high temperatures during fire exposure.

(ii) Some of the clay tile designs take advantage of these factors. The double cell design, for instance, insures that there is a cavity near the unexposed face. Some floor/ceiling assemblies have air gaps or cavities near the top surface and these enhance their thermal performance.

Rule 5: The fire endurance of a construction cannot be increased by increasing the thickness of a completely enclosed air layer.

(i) Harmathy notes that there is evidence that if the thickness of the air layer is larger than about 1/2 inch, the heat transfer through the air layer depends only on the temperature of the bounding surfaces, and is practically independent of the distance between them. This rule is not applicable if the air layer is not completely enclosed, i.e., if there is a possibility of fresh air entering the gap at an appreciable rate.

Rule 6: Layers of materials of low thermal conductivity are better utilized on that side of the construction on which fire is more likely to happen.

(i) As in Rule 4, the reason lies in the heat transfer process, but here the conductivity of the solid is much less dependent on the ambient temperature. The low thermal conductor allows a substantial temperature gradient to be established across its thickness under transient heat flow conditions. This rule may not be applicable to materials undergoing physico-chemical changes accompanied by significant heat absorption or heat evolution.

Rule 7: The fire endurance of asymmetrical constructions depends on the direction of heat flow.

(i) This rule is a consequence of Rules 4 and 6 as well as other factors. This rule is useful in determining the relative protection of corridors and stairwells from the surrounding spaces. In addition, there are often situations where a fire is more likely, or potentially more severe, from one side or the other.

Rule 8: The presence of moisture, if it does not result in explosive spalling, increases the fire endurance.

(i) The flow of heat into an assembly is greatly hindered by the release and evaporation of the moisture found within cementitious materials such as gypsum, portland cement, or magnesium oxychloride. Harmathy has shown that the gain in fire endurance may be as high as 8 percent for each percent (by volume) of moisture in the construction. It is the moisture chemically bound within the construction material at the time of manufacture or processing that leads to increased fire endurance. There is no direct relationship between the relative humidity of the air in the pores of the material and the increase in fire endurance.

(ii) Under certain conditions there may be explosive spalling of low permeability cementitious materials such as dense concrete. In general, one can assume that extremely old concrete has developed enough minor cracking that this factor should not be significant.

Rule 9: Load-supporting elements, such as beams, girders and joists, yield higher fire endurances when subjected to fire endurance tests as parts of floor, roof, or ceiling assemblies than they would when tested separately.

(i) One of the fire endurance test criteria is the ability of a load-supporting element to carry its design load. The element will be deemed to have failed when the load can no longer be supported.

(ii) Failure usually results for two reasons. Some materials, particularly steel and other metals, lose much of their structural strength at elevated temperatures. Physical deflection of the supporting element, due to decreased strength or thermal expansion, causes a redistribution of the load forces and stresses throughout the element. Structural failure often results because the supporting element is not designed to carry the redistributed load.

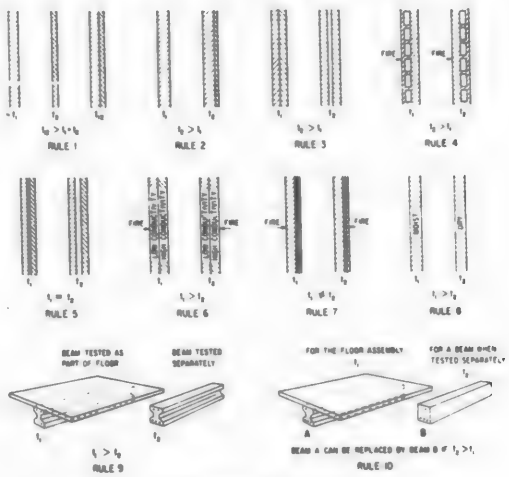
(iii) Roof, floor and ceiling assemblies have primary (e.g., beams) and secondary (e.g., floor joists) structural members. Since the primary load-supporting elements span the largest distances, their deflection becomes significant at a stage when the strength of the secondary members (including the roof or floor surface) is hardly affected by the heat. As the secondary members follow the deflection of the primary load-supporting element, an increasingly larger portion of the load is transferred to the secondary members.

(iv) When load-supporting elements are tested separately, the imposed load is constant and equal to the design load throughout the test. By definition, no distribution of the load is possible because the element is being tested by itself. Without any other structural members to which the load could be transferred, the individual elements cannot yield a higher fire endurance than they do when tested as parts of a floor, roof or ceiling assembly.

Rule 10: The load-supporting elements (beams, girders, joists, etc.) of a floor, roof, or ceiling assembly can be replaced by such other load-supporting elements which, when tested separately, yielded fire endurances not less than that of the assembly.

(i) This rule depends on Rule 9 for its validity. A beam or girder, if capable of yielding a certain performance when tested separately, will obviously yield an equally good or better performance when it forms a part of a floor, roof or ceiling assembly. It must be emphasized that the supporting element of one assembly must not be replaced by the supporting element of another assembly if the performance of this latter element is not known from a separate (beam) test. Because of the load-reducing effect of the secondary elements thats results from a test performed on an assembly, the performance of the supporting element alone cannot be evaluated by simple arithmetic. This rule clearly indicates the advantage of performing fire tests on primary load-supporting elements separately.

Harmathy (35) also provided one schematic figure which illustrated his Rules. This is shown below. It should be useful as a quick reference to assist in applying his Rules.



Diagrammatic illustration of ten rules

t fire endurance

Example Applications of Harmathy's Rules

The following examples, based in whole or in part upon those presented in Harmathy's paper (35), show how the Rules can be applied to practical cases.

Example 1

A. Problem

(i) A contractor would like to keep a partition which consists of a 3-3/4 inch thick layer of red clay brick, a 1-1/4 inch thick layer of plywood and a 3/8 inch thick layer of gypsum wallboard, at a location where 2-hour fire endurance is required. Is this assembly capable of providing a 2-hour protection?

B. Solution

(i) This partition does not appear in the Appendix Tables.

(ii) Bricks of this thickness yield fire endurances of approximately 75 minutes (Table 1.1.2, Item W-4-M-2).

(iii) The 1-1/4 inch thick plywood has a finish rating of 30 minutes.

(iv) The 3/8-inch gypsum wallboard has a finish rating of 10 minutes.

(v) Using the recommended values from the Tables and applying Rule 1, the fire endurance of the assembly is larger than the sum of the layers, or

$$> 75 + 30 + 10 = 115 \text{ minutes}$$

C. Discussion

(i) This example illustrates how the Appendix Tables can be utilized to determine the fire resistance of assemblies not listed explicitly.

Example 2

A. Problem

(i) A number of buildings to be rehabilitated have the same type of roof slab which is supported with different structural elements.

(ii) The designer and contractor would like to determine whether or not this roof slab is capable of yielding a 2-hour fire endurance. According to a rigorous interpretation of ASTM E-119, however, only the roof assembly, including the roof slab as well as the cover and the supporting elements, can be subjected to a fire test. Therefore, a fire endurance classification cannot be issued for the slabs separately.

(iii) The designer and contractor believe this slab will yield a 2-hour fire endurance even without the cover, and any beam of at least 2-hour fire endurance may serve as satisfactory support. Is it possible to obtain a classification for the slab separately?

B. Solution

(i) The answer to the question is yes.

(ii) According to Rule 10 it is not contrary to common sense to test and classify roofs and supporting elements

separately. Furthermore, according to Rule 2, if the roof slabs actually yield a 2-hour fire endurance, the endurance of an assembly, including the slabs, cannot be less than two hours.

(iii) The recommended procedure would be to review the Tables to see if the slab appears as part of any tested roof or floor/ceiling assembly. The supporting system can be regarded as separate from the slab specimen, and the fire endurance of the assembly listed in the Table is at least the fire endurance of the slab. There would have to be an adjustment for the weight of the roof cover in the allowable load if the test specimen did not contain a cover.

(iv) The supporting structure or element would have to have at least a 2-hour fire endurance when tested separately.

C. Discussion

(i) If the Tables did not include tests on assemblies which contained the slab, one procedure would be to assemble the roof slabs on any convenient supporting system (not regarded as part of the specimen) and to subject them to a load which, besides the usually required superimposed load, includes some allowances for the weight of the cover.

Example 3

A. Problem

(i) A steel-joisted floor and ceiling assembly is known to have yielded a fire endurance of 1 hour and 35 minutes. At a certain location, a 2-hour endurance is required. What is the most economical way of increasing the fire endurance by at least 25 minutes?

B. Solution

(i) The most effective technique would be to increase the ceiling plaster thickness.

(ii) There may be another technique based on other principles, but an examination of the drawings would be necessary.

C. Discussion

(i) The additional plaster has at least three effects:

a) The layer of plaster is increased and thus there is a gain of fire endurance (Rule 1).

b) There is a gain due to shifting the air gap farther from the exposed surface (Rule 4).

c) There is more moisture in the path of heat flow to the structural elements (Rules 7 and 8).

(ii) The increase in fire endurance would be at least as large as that of the finish rating for the added thickness of plaster. The combined effects in (i) would further increase this by a factor of 2 x or more, depending on the geometry.

Example 4

A. Problem

(i) The fire endurance of item W-10-M-1 in Table 1.1.5 is 4-hours. This wall consists of two 3-3/4 inch thick layers of structural tiles separated by a 2 inch air gap and 3/4" portland cement plaster or stucco on both sides. If the actual wall in the building is identical to item W-10-M-1 except that it has a 4 inch air gap, can the fire endurance be estimated at 5 hours?

B. Solution

(i) The answer to the question is no.

(ii) Reason contained in Rule 5.

Example 5

A. Problem

(i) In order to increase the insulating value of its precast roof slabs, a company has decided to make the slabs using two layers of different concretes. The lower layer of the slabs, where the strength of the concrete is immaterial (all the tensile load is carried by the steel reinforcement), is now made from a concrete of low strength but good insulating value. For the upper layer, where the concrete is supposed to carry the compressive load, the original high strength, high thermal conductivity concrete has been retained. How will the fire endurance of the slabs be affected by the change?

B. Solution

The effect on the thermal fire endurance is beneficial:

(i) The total resistance to heat flow of the new slabs has been increased due to the replacement of a layer of high thermal conductivity by one of low conductivity.

(ii) The layer of low conductivity is on the side more likely to be exposed to fire, where it is more effectively utilized according to Rule 6. The layer of low thermal conductivity also provides better protection for the steel reinforcement; therefore, the time of attaining the temperature at which the creep of steel becomes significant will be extended.

C. "Thickness Design" Strategy

If a given wall does not appear in the Tables, a rehabilitation designer can utilize a "thickness design" strategy for walls which is based on Harmathy's Rules 1 and 2.

This "thickness design" approach is used when the materials have been identified and measured, but the specific wall is not included in the Tables. The first step is to survey thinner walls to see if the same materials have been fire tested and if thinner walls have yielded the desired or greater fire endurance. If that is the case, then the thicker walls in the building have more than enough fire resistance. The thickness of the walls thus becomes the principal concern.

This approach can also be used for floor/ceiling assemblies, except that the thickness of the cover * and the slab become the central concern. The fire resistance of assemblies with less cover and/or thinner slabs that are listed in the Tables can be used. For other structural elements (e.g., beams and columns), the element listed in the Table must be of a similar design but with less cover thickness.

Section IV

SUMMARY GUIDELINE

After the preliminary evaluation has been documented and a rehabilitation project is in the final design process, the need arises for specific guidelines for the evaluation of the fire-related performance of existing building elements. This section summarizes the various approaches and design solutions discussed in the preceeding Sections.

The term "structural system" includes: frames, beams, columns, and other structural elements. "Cover" has the meaning defined below: a protective layer(s) of materials or membrane which slows the flow of heat to the structural elements.

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* cover: the protective layer or membrane of material which slows the flow of heat to the structural elements.

The following approaches (i) through (iii) shall be considered equivalent.

(i) The fire resistance of a building element can be established from the Appendix Tables. This is subject to the following limitations:

a. The building element in the rehabilitated building shall be constructed of the same materials with the same nominal dimensions as stated in the Tables.

b. All penetrations in the building element or its cover for services such as electricity, plumbing, and HVAC shall be packed with noncombustible cementitious materials and so fixed that the packing material will not fall out when it loses its water of hydration.

c. The effects of age and wear and tear shall be repaired so that the building element is sound and the original thickness of all components, particularly covers and floor slabs, is maintained.

(ii) The fire resistance of a building element which does not explicitly appear in the Appendix Tables can be established if one or more elements of same design but different dimensions have been listed in the Tables. For walls, the existing element must be thicker than the one listed in the Table. The fire resistance of the thicker wall shall be considered that of the thinner wall which appears in the Table. For floor/ceiling assemblies, the assembly listed in the Table must have the same or less cover and the same or thinner slab constructed of the same material as the actual floor/ceiling assembly. For other structural elements, the element listed in the Table must be of a similar design but with less cover thickness. The fire resistance in all instances shall be the fire resistance rating recommended in the Table. This is subject to the following limitations:

a. The actual element in the rehabilitated building shall be constructed of the same materials as listed in the Table. Only the following dimensions may vary from those specified: for walls, the overall thickness must exceed that specified in the table; for floor/ceiling assemblies, the thickness of the cover and the slab must be greater than, or equal to, that specified in table; for other structural elements, the thickness of the cover must be greater than that specified in the table.

b. All penetrations in the building element or its cover for services such as electricity, plumbing, or HVAC shall be packed with noncombustible cementitious materials and so fixed that the packing material will not fall out when it loses its water of hydration.

c. The effects of age and wear and tear shall be repaired so that the building element is sound and the original thickness of all components, particularly covers and floor slabs, is maintained.

(iii) The fire resistance of building elements can be established by applying Harmathy's Ten Rules of Fire Resistance Ratings as set forth in Section III. This is subject to the following limitations:

a. The data from the Tables can be utilized with the limitations a. through c. from Guideline (i) above.

b. Test reports from recognized journals or published papers can be used to support data utilized in applying Harmathy's rules.

c. Calculations utilizing recognized and well established computational techniques can be used in applying Harmathy's Rules. These include, but are not limited to, analysis of heat flow, mechanical properties, deflections, and load bearing capacity.

COMMENTARY

(i) Guideline (i) essentially follows the approach taken by model building codes. The assembly must appear in a table either published in or accepted by the code for a given fire resistance rating to be recognized and accepted.

(ii) Guideline (ii) is an application of the "thickness design" concept presented in Section III. There should be many instances when a thicker building element was utilized than the one listed in the Appendix Tables. This Guideline recognizes the inherent superiority of a thicker design. Note: "thickness design" for floor/ceiling assemblies and structural elements refers to cover and slab thickness rather than total thickness.

(iii) The "thickness design" concept is essentially a special case of Guideline (iii) which takes special cognizance of Harmathy's Ten Rules (specifically Rules 1 and 2). It should be recognized that the only source of data for Guideline (ii) is the Appendix Tables. If other data is used, it must be in connection with Guideline (iii).

(iv) The fire endurance of actual building elements can be greatly reduce or totally negated by removing part of the cover to allow pipes, ducts, or conduits to pass through the element. This must be repaired in the rehabilitation process.

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SECTION I

WALLS

INTRODUCTION

The tables and histograms which follow are to be used only within the analytical framework detailed in the main body of this Guideline.

Histograms precede any table with 10 or more entries. The use and interpretation of these histograms is explained in Section II of the Guideline. The tables are in a format similar to that found in the model building codes. The following example, taken from an entry in Table 1.1.2, best explains the table format.

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-4-M-50	4-5/8"	Core: structural clay tile; See notes 12,16,21; Facings on unexposed side only; see note 18.	n/a	25 min.		1		3, 4, 24	1/3

1. Item Code: The item code consists of a four place series in the general form w-x-y-z in which each member of the series denotes the following:
   w = Type of building element (e.g. W=Walls; F=Floors, etc.)
   x = The building element thickness rounded down to the nearest one inch increment (e.g. 4-5/8" is rounded off to 4")
   y = The general type of material from which the building element is constructed (e.g. M=Masonry; W=Wood, etc.)
   z = The item number of the particular building element in a given table

   The item code shown in the example W-4-M-50 denotes the following:
   W = wall, as the building element
   4 = wall thickness in the range of 4" to less than 5"
   M = Masonry construction
   50 = The 50th entry in Table 1.1.2

2. The specific name or heading of this column identifies the dimension which, if varied, has the greatest impact on fire resistance. The critical dimension for walls, the example here, is thickness. It is different for other building elements (e.g. depth for beams; membrane thickness for some floor/ceiling assemblies). The table entry is the named dimension of the building element measured at the time of actual testing to within ± 1/8" tolerance.

3. Construction Details: The construction details provide a brief description of the manner in which the building element was constructed.

4. Performance: This heading is subdivided into two columns. The column labeled "Load" will either list the load that the building element was subjected to during the fire test or it will contain a note number which will list the load and any other significant details. If the building element was not subjected to a load during the test this column will contain "n/a" which means "not applicable".

   The second column under performance is labeled "Time" and denotes the actual fire endurance time observed in the fire test.

5. Reference Number: This heading is subdivided into three columns: Pre-BMS-92; BMS-92; and Post BMS-92. The table entry under this column is the number in the Bibliography of the original source reference for the test data.

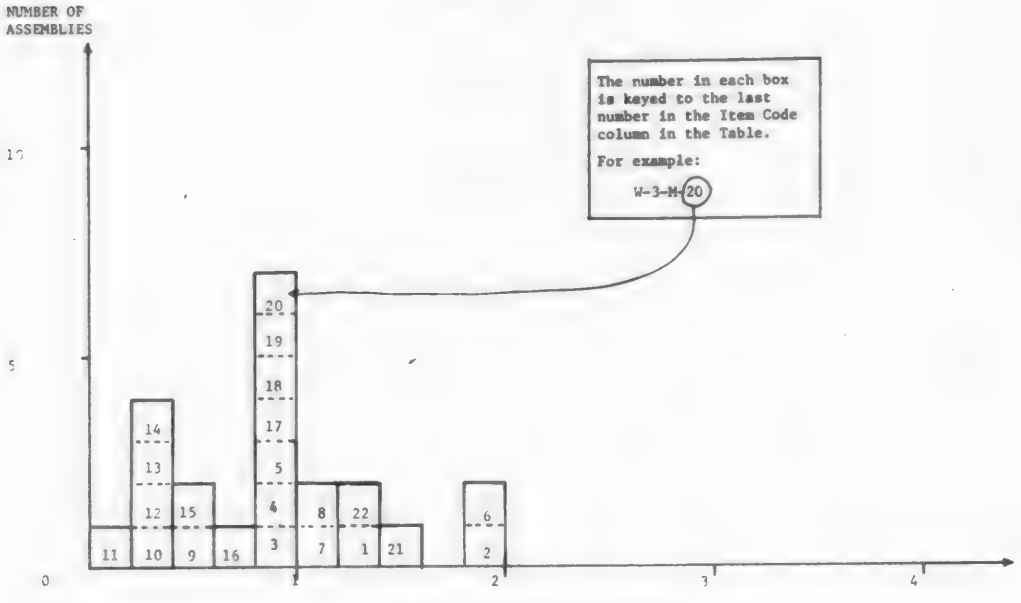
6. Notes: Notes are provided at the end of each table to allow a more detailed explanation of certain aspects of the test. In certain tables the notes given in this column have also been listed under the "Construction Details" and/or "Load" columns.

7. Rec Hours: This column lists the recommended fire endurance rating, in hours, of a building element. In some cases, the recommended fire endurance will be less than that listed under the "Time" column. In no case is the "Rec Hours" greater than given in the "Time" column.

FIGURE 1.1.1

WALLS - MASONRY

Thickness - 4" or less



FIRE RESISTANCE RATING (HOURS)

TABLE 1.1.1

MASONRY WALLS

Walls Less Than 4" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-2-M-1	2½"	Solid partition; 3/4" gypsum plank - 10'x 1'6"; 3/4"+ gypsum plaster each side.	n/a	1 hr. 22min			7	1	1-1/4
W-3-M-2	3"	Concrete block (18"x 9"x 3") of fuel ash, portland cement and plasticizer; Cement/sand mortar.	n/a	2 hr.			7	2,3	2
W-2-M-3	2"	Solid gypsum block wall; No facings.	n/a	1 hr.		1		4	1
W-3-M-4	3"	Solid gypsum blocks, laid in 1:3 sanded gypsum mortar	n/a	1 hr.		1		4	1
W-3-M-5	3"	Magnesium oxysulfate wood fiber blocks; 2" thick; Laid in portland cement-lime mortar; Facings: ½" of 1:3 sanded gypsum plaster on both sides.	n/a	1 hr.		1		4	1
W-3-M-6	3"	Magnesium oxysulfate bound wood fiber blocks; 3" thick; Laid in portland cement-lime mortar; Facings: ½" of 1:3 sanded gypsum plaster on both sides.	n/a	2 hr.		1		4	2
W-3-M-7	3"	Clay tile; Ohio fire clay; single cell thick; Face plaster 5/8" (both sides) 1:3 sanded gypsum; Construction "A"; Design E.	n/a	2 hr. 6 min.			2	5,6,7 11,12 39	1

1.1.1 (cont'd)

Walls Less Than 4" Thick

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-3-M-8	3"	Clay tile; Illinois surface clay; single cell thick; face plaster 5/8" (both sides) 1:3 sanded gypsum; Design A; Construction "E".	n/a	1 hr 1 min.			2	3,8,9 11,12 39	
W-3-M-9	3"	Clay tile; Illinois surface clay; single cell thick; no face plaster; Construction "C", Design "A".	n/a	25min.			2	3,10 11,12 39	1/3
W-3-M-10	3-7/8"	8"x 4-7/8" glass blocks; weight 4 lb. each; portland cement-lime mortar; horizontal mortar joints reinforced with metal lath.	n/a	15min.		1		4	1/6
W-3-M-11	3"	Core: Structural clay tile; See notes 14,18,23 No facings.	n/a	10min.		1		5,11, 26	1/6
W-3-M-12	3"	Core: Structural clay tile; See notes 14,19,23 No facings.	n/a	20min.		1		5,11, 26	1/3
W-3-M-13	3-5/8"	Core: Structural clay tile; See notes 14,18,23; Facings on unexposed side per note 20.	n/a	20min.		1		5,11, 26	1/3
W-3-M-14	3-5/8"	Core: Structural clay tile; See notes 14,19,23; Facings on unexposed side only per note 20.	n/a	20min.		1		5,11 26	1/3
W-3-M-15	3-5/8"	Core: Clay structural tile; See notes 14,18,23; Facings on side exposed to fire per note 20.	n/a	30min.		1		5,11 26	1/2
W-3-M-16	3-5/8"	Core: Clay structural tile; See notes 14,19,23; Facing on side exposed to fire per note 20.	n/a	45min.		1		5,11 26	3/4
W-2-M-17	2"	2" thick solid gypsum blocks; See note 27.	n/a	1 hr.		1		27	1
W-3-M-18	3"	Core: 3" thick gypsum blocks 70% solid; See note 2.; No facings.	n/a	1 hr.		1		27	1
W-3-M-19	3"	Core: Hollow concrete units; See notes 29,35, 36,38; No facings	n/a	1 hr.		1		27	1
W-3-M-20	3"	Core: Hollow concrete units; See notes 28,35, 36,37,38; No facings.	n/a	1 hr.		1			1
W-3-M-21	3½"	Core: Hollow concrete units; See notes 28,35, 36,37,38; Facings on one side, see note 37.	n/a	1½ hr.		1			1½
W-3-M-22	3½"	Core: Hollow concrete units; See notes 29,35, 36,38; Facings on one side per note 37.	n/a	1¾ hr.		1			1¾

TABLE 1.1.1

NOTES

1. Failure mode - flame thru
2. Passed 2 hr. fire test (Grade "C" fire res. - British).
3. Passed hose stream test.
4. Tested at NBS under ASA. Spec. No. A2-1934. As non-load bearing partitions.
5. Tested at NBS under ASA Spec. No. 42-1934 (ASTM C-19-33) except that hose stream testing where carried out was run on test specimens exposed for full test duration, not for a reduced period as is contemporarily done.
6. Failure by thermal criteria - maximum temperature rise 181°C (325°F).
7. Hose stream failure.
8. Hose stream - pass.
9. Specimen removed prior to any failure occurring.
10. Failure mode - collapse.
11. For clay tile walls, unless the source of the clay can be positively identified, it is suggested that the most pessimistic hour rating for the fire endurance of a clay tile partition of that thickness be followed. Identified sources of clay showing longer fire endurance can lead to longer time recommendations.
12. See appendix for construction and design details for clay tile walls.

1.1.1 (cont'd)

NOTES

13. Load - 80 PSI for gross wall area.

14. One cell in wall thickness.

15. Two cells in wall thickness.

16. Double shells plus one cell in wall thickness.

17. One cell in wall thickness, cells filled with broken tile, crushed stone, slag cinders or sand mixed with mortar.

18. Dense hard-burned clay or shale tile.

19. Medium-burned clay tile.

20. Not less than 5/8" thickness of 1:3 sanded gypsum plaster.

21. Units of not less than 30% solid material.

22. Units of not less than 40% solid material.

23. Units of not less than 50% solid material.

24. Units of not less than 45% solid material.

25. Units of not less than 60% solid material.

26. All tiles laid in portland cement-lime mortar.

27. Blocks laid in 1:3 sanded gypsum mortar voids in blocks not to exceed 30%.

28. Units of expanded slag or pumice aggregates.

29. Units of crushed limestone, blast furnace slag, cinders and expanded clay or shale.

30. Units of calcareous sand and gravel. Coarse aggregate, 60% or more calcite and dolomite.

31. Units of siliceous sand and gravel. 90% or more quartz, chert or flint.

32. Unit at least 49% solid..

33. Unit at least 62% solid.

34. Unit at least 65% solid.

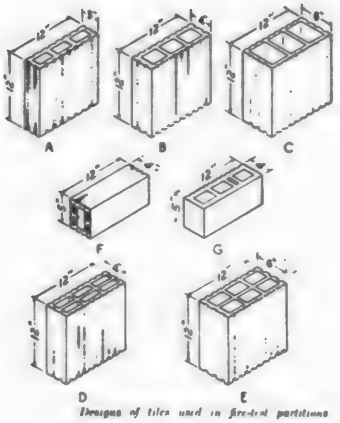
35. Unit at least 73% solid.

36. Ratings based on one unit and one cell in wall thickness.

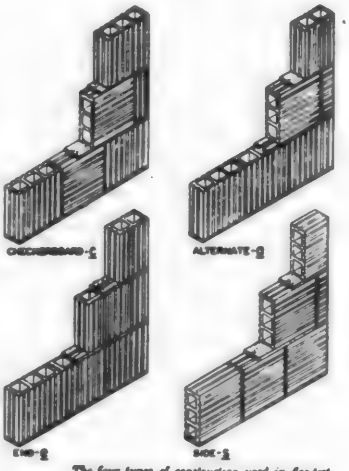
37. Minimum of ½" - 1:3 sanded gypsum plaster.

38. Non-load bearing.

39. See Clay Tile Partition Design Construction drawings, below.



Designs of tiles used in fire-test partitions



The four types of construction used in fire-test partitions.

FIGURE 1.1.2

WALLS - MASONRY

Thickness 4" to Less Than 6"

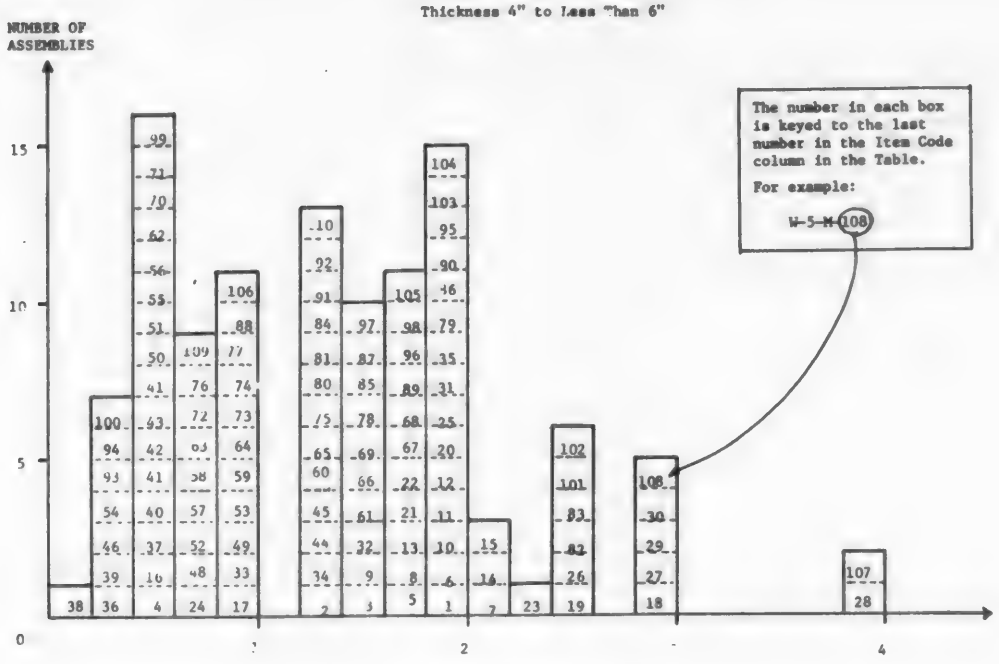


TABLE 1.1.2

MASONRY WALLS

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-4-M-1	4"	Solid 3" thick, gypsum blocks laid in 1:3 sanded gypsum mortar; Facings: ½" of 1:3 sanded gypsum plaster(both sides).	n/a	2 hr.		1		1	2
W-4-M-2	4"	Solid clay or shale brick.	n/a	1 hr. 15min.		1		1,2	1-1/4
W-4-M-3	4"	Concrete; No facings.	n/a	1 hr. 30min.		1		1	1½
W-4-M-4	4"	Clay tile; Illinois surface clay; Single cell thick; No face plaster; Constr."C"; Design "B".	n/a	25min.			2	3-7 36	1/3
W-4-M-5	4"	Solid sand-lime brick	n/a	1 hr. 45min.		1		1	1-3/4
W-4-M-6	4"	Solid wall; 3" thick block; ½" plaster each side; 17-3/4"x 8-3/4" x 3" "Breeze Blocks"; portland cement/sand mortar.	n/a	1 hr. 52min.			7	2	1-3/4
W-4-M-7	4"	Concrete (4020 PSI); Reinforcement: Vertical 3/8"; horizontal ½"; 6"x 6" grid;	3.4 tons/ foot	2 hr. 10min.			7	2	2

1.1.2 (cont'd)

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hour
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-4-M-8	4"	Concrete wall(4340 PSI Crush); Reinforcement: ¼" diameter rebar on 8" centers (vertical and horizontal);	n/a	1 hr. 40min.			7	2	1-2/3
W-4-M-9	4-3/16"	4-3/16"x 2-5/8" cellular fletton brick (1873 PSI) with ½" sand mortar; bricks are U-shaped yielding hollow cover (approx. 2"x 4") in final (cross-section)configuration.	n/a	1 hr. 25min.			7	2	1-1/3
W-4-M-10	4½"	4½"x 2½" fletton (1831 PSI) brick in ½" sand mortar.	n/a	1 hr. 53min.			7	2	1-3/4
W-4-M-11	4½"	4½"x 2½" London stock (683 PSI) brick; ½" grout.	n/a	1 hr. 52min.			7	2	1-3/4
W-4-M-12	4½"	4½" x 2½" Leicester Red, Wire-cut brick (4465 PSI) in ½" sand mortar.	n/a	1 hr. 56min.			7	6	1-3/4
W-4-M-13	4½"	4½" x 2½" Stairfoot brick (7527 PSI) ½" sand mortar.	n/a	1 hr. 37min.			7	2	1½
W-4-M-14	4½"	4½"x 2½" Sandlime brick (2603 PSI) ½" sand mortar.	n/a	2 hr. 6 min.			7	2	2
W-4-M-15	4½"	4½"x 2½" concrete brick (2527 PSI) 1/2" sand mortar.	n/a	2 hr. 10min.			7	2	2
W-4-M-16	4½"	4" thick clay tile; Ohio Fire Clay; Single cell thick; No plaster exposed face; ½" 1:2 gypsum back face; Constr. g; Design "p".	n/a	31min.			2	3-6 36	½
W-4-M-17	4½"	4" thick clay tile; Ohio fire clay; Single cell thick; plaster exposed face: ½"; 1:2 sanded gypsum; back face: none; Design "P"; Constr. "E".	80 PSI	50min.			2	3-5,8 36	3/4
W-4-M-18	4½"	Core: Solid sand-lime brick; 1/2" sanded gypsum plaster facings on both sides.	80 PSI	3 hr.		1		1,11	3
W-4-M-19	4½"	Core: Solid sand-lime brick; ½" sanded gypsum plaster facings on both sides.	80 PSI	2 hr. 30min.		1		1,11	2½
W-4-M-20	4½"	Core: Concretebrick ½" of 1:3 sanded gypsum plaster facings on both sides.	80 PSI	2 hr.		1		1,11	2
W-4-M-21	4½"	Core: Solid clay or shale bricks; ½" thick, 1:3 sanded gypsum plaster facings on fire sides.	80 PSI	1 hr. 45 min.		1		1,2 11	1-3/4
W-4-M-22	4-3/4"	4" thick clay tile; Ohio fire clay; single cell thick; cells filled with cement and broken tile concrete; plaster on exposed face: none on unexposed face 3/4" 1:3 sanded gypsum; Constr. "E"; Design "G".	n/a	1 hr. 48 min.			2	2,3-5, 9 36	1-3/4
W-4-M-23	4-3/4"	4" thick clay tile; Ohio fire clay; single cell thick; cells filled with cement and broken tile concrete; no plaster exposed face; 3/4" neat gypsum plaster on unexposed face; Design "G"; Constr. "E".	n/a	2 hr. 14 min.			2	2,3-5 9 36	2
W-5-M-24	5"	3"x 13" airspace; 1" thick metal reinforced concrete facings on both sides; faces connected with wood splines.	2,250 lb/ft.	45min.		1		1	3/4
W-5-M-25	5"	Core: 3" thick void filled with "modulated" mineral wool weighing 10 lbs/ft^3; 1" thick metal reinforced concrete facings on both sides.	2,250 lb/ft	2 hr.		1		1	2
W-5-M-26	5"	Core: Solid clay or shale brick; ½" thick, 1:3 sanded gypsum plaster facings on both sides.	40 PSI	2 hr. 30min.		1		1,2 11	2½
W-5-M-27	5"	Core: Solid 4" thick gypsum blocks, laid in 1:3 sanded gypsum mortar; ½" of 1:3 sanded gypsum plaster facings on both sides.	n/a	3 hr.		1		1	3
W-5-M-28	5"	Core: 4" thick hollow gypsum blocks with 30% voids; blocks laid in 1:3 sanded gypsum mortar No facings.	n/a	4 hr.		1		1	4
W-5-M-29	5"	Core: concrete brick; ½" of 1:3 sanded gypsum plaster facings on both sides.	160 PSI	3 hr.		1		1	3

1.1.2 (cont'd)

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-5-M-30	5⅛"	4" thick clay tile; Illinois surface clay; double cell thick; plaster - 5/8" thick sanded gypsum 1:3 both faces; Design "b"; Constr. "S".	n/a	2 hr. 53min.			2	2-5,9 36	2-3/4
W-5-M-31	5⅛"	4" thick clay tile; New Jersey fire clay; double cell thick; plaster - 5/8" sanded gypsum 1:3 both faces; Design"D"; Constr."S".	n/a	1 hr. 52min.			2	2-5,9 36	1-3/4
W-5-M-32	5⅛"	4" thick clay tile; New Jersey fire clay; single cell thick; 5/8" plaster on both sides; 1:3 sanded gypsum; Design"D"; Constr."S"	n/a	1 hr. 34min.			2	2-5,9 36	1⅓
W-5-M-33	5⅛"	4" thick clay tile; New Jersey Fire Clay; single cell thick; face plaster - 5/8" both sides; 1:3 sanded gypsum; Constr. "S"; Design "B".	n/a	50min.			2	3-5,8 36	3/4
W-5-M-34	5⅛"	4" thick clay tile; Ohio fire clay; single cell thick; face plaster - 5/8" both sides; 1:3 sanded gypsum; Constr. "A"; Design "B".	n/a	1 hr. 19min.			2	2-5,9 36	1⅛
W-5-M-35	5⅛"	4" thick clay tile; Illinois Surface Clay; single cell thick; face plaster - 5/8" both sides; 1:3 sanded gypsum; Constr."S"; Design "B".	n/a	1 hr. 59min.			2	2-5, 10 36	1-3/4
W-4-M-36	4"	Core: Structural clay tile; See notes 12,16,21; No facings.	n/a	15min.		1		3,4, 24	½
W-4-M-37	4"	Core: structural clay tile; See notes 12,17,21; No facings.	n/a	25min.		1		3,4, 24	1/3
W-4-M-38	4"	Core: structural clay tile; See notes 12,16,20; No facings.	n/a	10 min		1		3,4, 24	1/6
W-4-M-39	4"	Core: structural clay tile; See notes 12,17,20; No facings.	n/a	20 min		1		3,4, 24	1/3
W-4-M-40	4"	Core: structural clay tile; See notes 13,16,23; No facings.	n/a	30 min		1		3,4 24	½
W-4-M-41	4"	Core: structural clay tile; See notes 13,17,23; No facings.	n/a	35 min		1		3,4, 24	½
W-4-M-42	4"	Core: structural clay tile; See notes 13,16,21 No facings.	n/a	25 min		1		3,4, 24	1/3
W-4-M-43	4"	Core: structural clay tile; See notes 13,17,21 No facings.	n/a	30 min		1		3,4, 24	1/2
W-4-M-44	4"	Core: structural clay tile; see notes 15,16,20; No facings.	n/a	1 hr. 15 min		1		3,4 24	1⅛
W-4-M-45	4"	Core: structural clay tile; See notes 15,17,20; No facings.	n/a	1 hr. 15 min		1		3,4 24	1⅛
W-4-M-46	4"	Core: structural clay tile; See notes 14,16,22; No facings.	n/a	20 min		1		3,4, 24	1/3
W-4-M-47	4"	Core: strucutural clay tile; See notes 14,17,22 No facings.	n/a	25 min		1		3,4 24	1/3
W-4-M-48	4⅛"	Core: clay structural tile; See notes 12,16,21; Facings on both sides; see note 18.	n/a	45 min		1		3,4 24	3/4
W-4-M-49	4⅛"	Core: clay structural tile; See notes 12,17,21; Facings on both sides; see note 18.	n/a	1 hr.		1		3,4 24	1
W-4-M-50	4-5/8"	Core: structural clay tile; See notes 12,16,21; Facings on unexposed side only; see note 18.	n/a	25 min		1		3,4, 24	1/3

1.1.2 (cont'd)

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BNS-92	BNS -92	Post-BNS-92		
W-4-M-51	4-5/8"	Core: structural clay tile; See notes 12,17,21; Facings on unexposed side only; see note18.	n/a	30 min		1		3,4, 24	½
W-4-M-52	4-5/8"	Core: structural clay tile; See notes 12,16,21; Facings exposed side only, See note 18.	n/a	45 min		1		3,4 24	3/4
W-4-M-53	4-5/8	Core: strucutral clay tile; See notes 12,17,21; Facings: fire side only; see note 18.	n/a	1 hr.		1		3,4 24	1
W-4-M-54	4-5/8"	Core: structural clay tile; See notes 12,16,20; Facings on unexposed side; see note 18.	n/a	20 min		1		3,4, 24	1/3
W-4-M-55	4-5/8"	Core: structural clay tile; See notes 12,17,20; Facings: on unexposed side; see note 18.	n/a	25 min		1		3,4 24	1/3
W-4-M-56	4-5/8"	Core: structural clay tile; See notes 12,16,20; Facings on fire side only ;see note 18.	n/a	30 min		1		3,4 24	½
W-4-M-57	4-5/8"	Core: structural clay tile; See notes 12,17,20; Facings on fire side only; see note 18.	n/a	45 min		1		3,4 24	3/4
W-4-M-58	4-5/8"	Core: structural clay tile; See notes 13,16,23; Facings on unexposed side only; see note 18.	n/a	40 min		1		3,4, 24	2/3
W-4-M-59	4-5/8"	Core: structural clay tile; See notes 13,17,23; Facing: on unexposed side only; see note 18.	n/a	1 hr.		1		3,4, 24	1
W-4-M-60	4-5/8"	Core: structural clay tile; See notes 13,16,23; Facing on fire side only; see note 18.	n/a	1 hr. 15 min		1		3,4 24	1¼
W-4-M-61	4-5/8"	Core: structural clay tile; See notes 13,17,23; Facing on fire side only; See note 18.	n/a	1 hr. 30 min		1		3,4, 24	1½
W-4-M-62	4-5/8"	Core: structural clay tile; See notes 13,16,21; Facing on unexposed side only; See note 18.	n/a	35 min		1		3,4 24	½
W-4-M-63	4-5/8"	Core: structural clay tile; See notes 13,17,21; Facing on unexposed face only; See note 18.	n/a	45 min		1		3,4, 24	3/4
W-4-M-64	4-5/8"	Core: structural clay tile; See notes 13,16,23; Facing on exposed face only; See note 18.	n/a	1 hr.		1		3,4, 24	1
W-4-M-65	4-5/8"	Core: structural clay tile; See notes 13,17,21; Facing on exposed side only; See note 18.	n/a	1 hr. 15 min		1		3,4, 24	1¼
W-4-M-66	4-5/8"	Core: structural clay tile; See notes 15,17,20; Facings on unexposed side only; See note 18.	n/a	1 hr. 30 min		1		3,4, 24	1½
W-4-M-67	4-5/8"	Core: structural clay tile; See notes 15,16,20; Facings on exposed side only, See note 18.	n/a	1 hr. 45 min		1		3,4, 24	1-3/4
W-4-M-68	4-5/8"	Core: structural clay tile: See notes 15,17,20; Facings on exposed side only, see note 18.	n/a	1 hr. 45 min		1		3,4, 24	1-3/4
W-4-M-69	4-5/8"	Core: structural clay tile; See notes 15,16,20; Facings on unexposed side only, see note 18.	n/a	1 hr. 30 min		1		3,4 24	1½
W-4-M-70	4-5/8"	Core: structural clay tile; See notes 14,16,22; Facings on unexposed side only, See note 18.	n/a	30 min		1		3,4, 24	½
W-4-M-71	4-5/8"	Core: structural clay tile; See notes 14,17,22; Facings on unexposed side only; see note 18.	n/a	35 min		1		3,4, 24	½
W-4-M-72	4-5/8"	Core: structural clay tile: See notes 14,16,22; Facings on fire side of wall only; See note 18.	n/a	45 min		1		3,4 24	3/4
W-4-M-73	4-5/8"	Core: structural clay tile; See notes 14,17,22; Facings on fire side of wall only; See note 18.	n/a	1 hr.		1		3,4, 24	1
W-5-M-74	5⅛"	Core: structural clay tile; see notes 12,16,21; Facings on both sides; see note 18.	n/a	1 hr.		1		3,4, 24	1
W-5-M-75	5⅛"	Core: structural clay tile: see notes 12,17,21; Facings on both sides; see note 18.	n/a	1 hr. 15 min		1		3,4 24	1¼
W-5-M-76	5⅛"	Core: structural clay tile: see notes 12,16,20; Facings on both sides; see note 18.	n/a	45 min		1		3,4, 24	3/4

1.1.2 (cont'd)

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-5-M-77	5⅛"	Core: structural clay tile; see notes 12,17,20; Facings on both sides; see note 18.	n/a	1 hr.		1		3,4, 24	1
W-5-M-78	5⅛"	Core: structural clay tile; see notes 13,16,23; Facings on both sides of wall; see note 18.	n/a	1 hr. 30 min		1		3,4, 24	1½
W-5-M-79	5⅛"	Core: structural clay tile; see notes 13,17,23; Facings on both sides of wall, see note 18.	n/a	2 hrs.		1		3,4, 24	2
W-5-M-80	5⅛"	Core: structural clay tile; see notes 13,16,21; Facings on both sides of wall; see note 18.	n/a	1 hr. 15 min		1		3,4, 24	1¼
W-5-M-81	5⅛"	Core: structural clay tile; See notes 13,16,21; Facing on both sides of wall; see note 18.	n/a	1 hr. 30 min		1		3,4 24	1½
W-5-M-82	5⅛"	Core: structural clay tile; see notes 15,16,20; Facings on both sides; see note 18.	n/a	2 hrs 30 min		1		3,4, 24	2½
W-5-M-83	5⅛"	Core: structural clay tile; see notes 15,17,20; Facings on both sides; see note 18.	n/a	2 hrs. 30 min		1		3,4, 24	2½
W-5-M-84	5⅛"	Core: structural clay tile; see notes 14,16,22; Facings on both sides of wall; see note 18.	n/a	1 hr. 15 min		1		3,4 24	1¼
W-5-M-85	5⅛"	Core: structural clay tile; see notes 14,17,22 Facings on both sides of wall; see note 18.	n/a	1 hr. 30 min		1		3,4, 24	1½
W-4-M-86	4"	Core: 3" thick gypsum blocks 70% solid; see note 26; Facings on both sides per note 25.	n/a	2 hrs.		1			2
W-4-M-87	4"	Core: hollow concrete units; see notes 27,34, 35; No facings.	n/a	1 hr. 30 min		1			1½
W-4-M-88	4"	Core: hollow concrete units; see notes 28,33, 35; No facings.	n/a	1 hr.		1			1
W-4-M-89	4"	Core: hollow concrete units; see notes 28,34, 35; Facings on both sides per note 25.	n/a	1 hr. 45min.		1			1-3/4
W-4-M-90	4"	Core: hollow concrete units; see notes 27,34, 35; Facings on both sides per note 25.	n/a	2 hrs.		1			2
W-4-M-91	4"	Core: hollow concrete units; see notes 27,32, 35; No facings.	n/a	1 hr. 15 min		1			1¼
W-4-M-92	4"	Core: hollow concrete units; see notes 28,34, 35; No facings.	n/a	1 hr. 15 min		1			1¼
W-4-M-93	4"	Core: hollow concrete units; see notes 29,32, 35; No facings.	n/a	20 min		1			1/3
W-4-M-94	4"	Core: hollow concrete units; see notes 30,34, 35; No facings.	n/a	15 min		1			¼
W-4-M-95	4½"	Core: hollow concrete units; see notes 27,34, 35; Facing on one side only, see note 25.	n/a	2 hrs.		1			2
W-4-M-96	4½"	Core: hollow concrete units; see notes 27,32, 35; Facing on one side only, see note 25.	n/a	1 hr. 45 min		1			1-3/4
W-4-M-97	4½"	Core: hollow concrete units; see notes 28,33, 35; Facings on one side per note 25.	n/a	1 hr. 30 min		1			1½
W-4-M-98	4½"	Core: hollow concrete units; see notes 28,34, 35; Facings on one side only per note 25.	n/a	1 hr. 45 min		1			1-3/4
W-4-M-99	4½"	Core: hollow concrete units; see notes 29,32, 35; Facing on one side per note 25.	n/a	30 min		1			½
W-4-M-100	4½"	Core: hollow concrete units; see notes 30,34, 35; Facing on one side per note 25.	n/a	20 min		1			1/3
W-5-M-101	5"	Core: hollow concrete units; see notes 27,34, 35; Facings on both sides, see note 25.	n/a	2 hrs 30 min		1			2½

1.1.2 (cont'd)

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-5-M-102	5"	Core: hollow concrete units; see notes 27,32, 35; Facings on both sides per note 25.	n/a	2 hrs. 30 min		1			2½
W-5-M-103	5"	Core: hollow concrete units; see notes 28,33 35; Facings on both sides per note 25.	n/a	2 hrs.		1			2
W-5-M-104	5"	Core: hollow concrete units; see notes 28,31, 35; Facings on both sides per note 25.	n/a	2 hrs.		1			2
W-5-M-105	5"	Core: hollow concrete units; see notes 29,32, 35; Facings on both sides per note 25.	n/a	1 hr. 45 min		1			1-3/4
W-5-M-106	5"	Core: hollow concrete units; see notes 30,34, 35; Facings on both sides per note 25.	n/a	1 hr.		1			1
W-5-M-107	5"	Core: 5" thick solid gypsum blocks; see note 26; No facings.	n/a	4 hrs.		1			4
W-5-M-108	5"	Core: 4" thick hollow gypsum blocks; see note 26; Facings on both sides per note 25.	n/a	3 hrs.		1			3
W-5-M-109	4"	Concrete with 4"x 4" No. 6 welded wire mesh at wall center.	100 PSI	45 min			43	2	3/4
W-5-M-110	4"	Concrete with 4"x 4" No. 6 welded wire mesh at wall center.	n/a	1 hr. 15 min			43	2	1¼

TABLE 1.1.2

NOTES

1. Tested at NBS under ASA Spec No. A 2-1934.
2. Failure mode - maximum temperature rise.
3. Tested at NBS under ASA Spec. No. 42-1934 (ASTM C-19-53) except that hose stream testing where carried out was run on test specimens exposed for full test duration, not for or reduced period as is contemporarily done.
4. For clay tile walls, unless the source of the clay can be positively identified, it is suggested that the most pessimistic hour rating for the fire endurance of a clay tile partition of that thickness be followed. Identified sources of clay showing longer fire endurance can lead to longer time recommendations.
5. See appendix for construction and design details for clay tile walls.
6. Failure mode - flame thru or crack formation showing flames.
7. Hole formed at 25 min.; partition collapsed at 42 min. on removal from furnace.
8. Failure mode - collapse.
9. Hose stream pass.
10. Hose stream hole formed in specimen.
11. Load - 80 PSI for gross wall cross sectioned area.
12. One cell in wall thickness.
13. Two cells in wall thickness.

1.1.2 (cont'd)

NOTES

14. Double cells plus one cell in wall thickness.

15. One cell in wall thickness, cells filled with broken tile, crushed stone, slag, cinders or sand mixed with mortar.

16. Dense hard-burned clay or shale tile.

17. Medium-burned clay tile.

18. Not less than 5/8" thickness of 1:3 sanded gypsum plaster.

19. Units of not less than 30% solid material.

20. Units of not less than 40% solid material.

21. Units of not less than 50% solid material.

22. Units of not less than 45% solid material.

23. Units of not less than 60% solid material.

24. All tiles laid in portland cement-lime mortar.

25. Minimum ½" - 1:3 sanded gypsum plaster.

26. Laid in 1:3 sanded gypsum mortar. Voids in hollow units not to exceed 30%.

27. Units of expanded slag or pumice aggregate.

28. Units of crushed limestone, blast furnace slag, cinders, and expanded clay or shale.

29. Units of calcareous sand and gravel. Coarse aggregate, 60% or more calcite and dolomite.

30. Units of siliceous sand and gravel. 90% or more quartz, chert or flint.

31. Unit at least 49% solid.

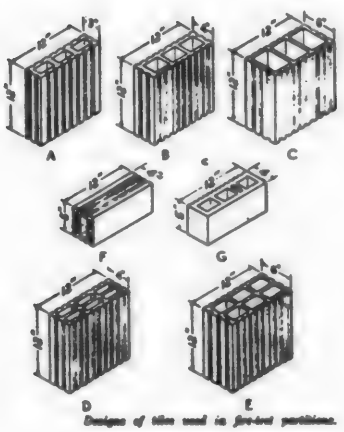
32. Unit at least 62% solid.

33. Unit at least 65% solid.

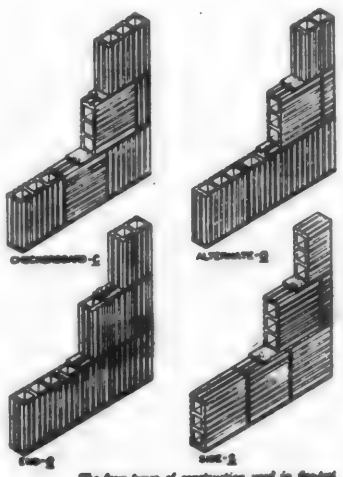
34. Unit at least 73% solid.

35. Ratings based on one unit and one cell in wall thickness.

36. See Clay Tile Partition Design Construction drawings, below.



Designs of tiles used in fire-test partitions.



The four types of construction used in fire-test partitions.

FIGURE 1.1.3

WALLS- "MASONRY"

Thickness - 6" To Less Than 8"

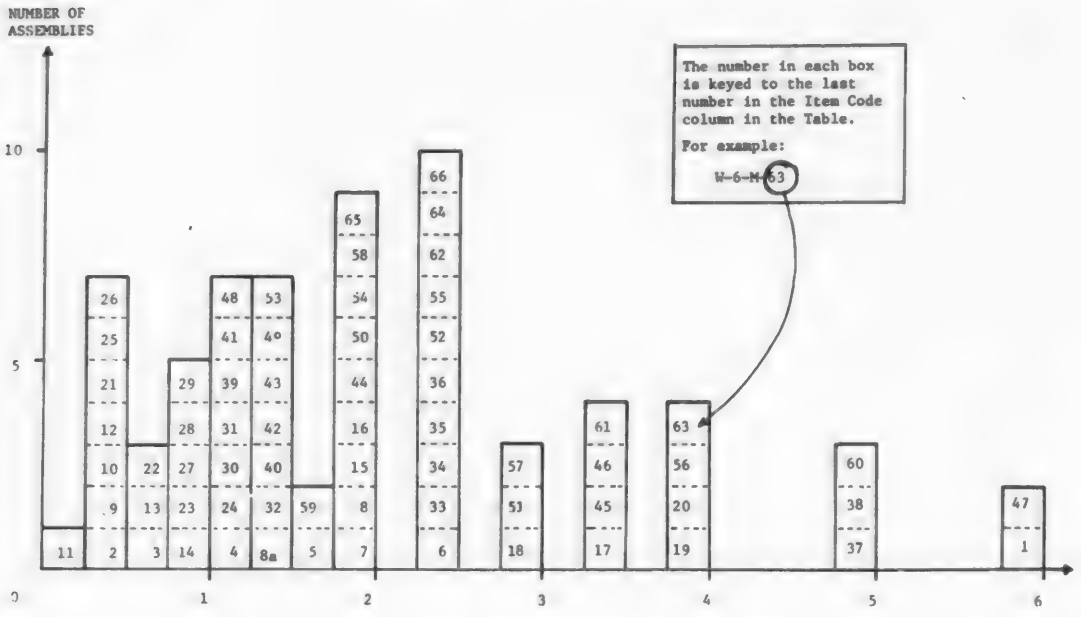


TABLE 1.1.3

MASONRY WALLS

Walls 6" Thick to Less Than 8"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-6-M-1	6"	Core: 5" thick, solid gypsum blocks laid in 1:3 sanded gypsum mortar; ½" of 1:3 sanded gypsum plaster facings on both sides.	n/a	6 hr.		1			6
W-6-M-2	6"	6" clay tile; Ohio fire clay; single cell thick; plaster - none; Design "C"; Constr. "A".	n/a	17 min			2	1,3,4 6 55	¼
W-6-M-3	6"	6" clay tile; Illinois surface clay; double cell thick; No plaster; Design "E"; Constr. "C".	n/a	45 min			2	1-4,7 55	3/4
W-6-M-4	6"	6" clay tile; New Jersey fire clay; double cell thick; No plaster; Design "E"; Constr."S".	n/a	1 hr. 1 min			2	1-4,8 55	1
W-7-M-5	7⅝"	6" clay tile; Illinois surface clay; double cell thick; Plaster: 5/8" - 1:3 sanded gypsum both faces; Design"E"; Constr."A".	n/a	1 hr. 41 min			2	1-4 55	1-2/3
W-7-M-6	7⅝"	6" clay tile New Jersey Fire Clay; Double cell thick; Plaster: 5/8" - 1:3 sanded gypsum both faces; Design "E"; Constr."S".	n/a	2 hr. 23 min			2	1-4,9 55	2-1/3
W-7-M-7	7⅝"	6" clay tile; Ohio fire clay; single cell thick; Plaster: 5/8" sanded gypsum; 1:3 both faces; Design"C"; Constr."A".	n/a	1 hr. 54 min			2	1-4,9 55	2-3/4

1.1.3 (cont'd)

Walls 6" Thick to Less Than 8"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-7-M-8	7⅝"	6" clay tile; Illinois surface clay; single cell thick; Plaster: 5/8" sanded gypsum 1:3 both faces; Design "C"; Constr."S".	n/a	2 hrs.			2	1,3,4 9,10 55	2
W-7-M-8a	7⅝"	6" clay tile; Illinois surface clay; single cell thick; Plaster: 5/8" sanded gypsum 1:3 both faces; Design "C"; Constr."S".	n/a	1 hr. 23 min			2	1-4 9,10 55	1½
W-6-M-9	6"	Core: Structural clay tile; See notes 12,16,20; No facings.	n/a	20 min		1		3,5, 24	1/3
W-6-M-10	6"	Core: structural clay tile; See notes 12,17,20; No facings.	n/a	25 min		1		3,5, 24	1/3
W-6-M-11	6"	Core: structural clay tile; See notes 12,16,19; No facings.	n/a	15 min		1		3,5 24	½
W-6-M-12	6"	Core: structural clay tile; See notes 12,17,19; No facings.	n/a	20 min		1		3,5 24	1/3
W-6-M-13	6"	Core: structural clay tile; See note 13,16,22; No facings.	n/a	45 min		1		3,5 24	3/4
W-6-M-14	6"	Core: structural clay tile; See notes 13,17,22; No facings.	n/a	1 hr.		1		3,5, 24	1
W-6-M-15	6"	Core: structural clay tile; See notes 15,17,19; No facings.	n/a	2 hr.		1		3,5, 24	2
W-6-M-16	6"	Core: structural clay tile; See notes 15,16,19; No facings.	n/a	2 hrs.		1		3,5, 24	2
W-6-M-17	6"	Cored concrete masonry; See notes 12,34,36,38, 41; No facings.	80 PSI	3 hrs. 30 min		1		5,25	3½
W-6-M-18	6"	Cored concrete masonry; See notes 12,33,36,38, 41; No facings.	80 PSI	3 hrs.		1		5,25	3
W-6-M-19	6½"	Cored concrete masonry; See notes 12,34,36,38, 41; Facings: See note 35 for side 1.	80 PSI	4 hrs.		1		5,25	4
W-6-M-20	6½"	Cored concrete masonry; See notes 12,33,36,38, 41; Facings: See note 35 for side 1.	80 PSI	4 hrs.		1		5,25	4
W-6-M-21	6-5/8"	Core: structural clay tile; See notes 12,16,20; Facing: unexposed face only, see note 18.	n/a	30min.		1		3,5, 24	½
W-6-M-22	6-5/8"	Core: structural clay tile; see notes 12,17,20; Facing: unexposed face only, see note 18.	n/a	40 min		1		3,5, 24,	2/3
W-6-M-23	6-5/8"	Core: structural clay tile; see notes 12,16,20; Facing: exposed face only, see note 18.	n/a	1 hr.		1		3,5 24	1
W-6-M-24	6-5/8"	Core: structural clay tile; see notes 12,17,20 Facing: exposed face only, see note 18.	n/a	1 hr. 5 min		1		3,5, 24	1
W-6-M-25	6-5/8"	Core: structural clay tile; see notes 12,16,19; Facing unexposed side only, see note 18.	n/a	25 min		1		3,5,24	1/3
W-6-M-26	6-5/8"	Core: structural clay tile; see notes 12,7,19; Facings: On unexposed side only, see note 18.	n/a	30min		1		3,5, 24	½
W-6-M-27	6-5/8"	Core: structural clay tile; see notes 12,16,19; Facings: on exposed side only, see note 18.	n/a	1 hr.		1		3,5, 24	1
W-6-M-28	6-5/8"	Core: structural clay tile; see notes 12,17,19 Facings: on fire side only, see note 18.	n/a	1 hr.		1		3,5, 24	1
W-6-M-29	6-5/8"	Core: structural clay tile; see notes 13,16,22; Facings: on unexposed side only, see note 18.	n/a	1 hr.		1		3,5, 24	1
W-6-M-30	6-5/8"	Core: structural clay tile; see notes 13,17,22; Facings: on unexposed side only, see note 18.	n/a	1 hr. 15min		1		3,5, 24	1½
W-6-M-31	6-5/8"	Core: structural clay tile; see notes 13,16,22; Facings: on fire side only, see note 18.	n/a	1 hr. 15min		1		3,5, 24	1½
W-6-M-32	6-5/8"	Core: structural clay tile; see notes 13,17,22; Facing: on fire side only, see note 18.	n/a	1 hr. 30 min		1		3,5 24	1½

1.1.3 (cont'd)

Wall 6" Thick to Less Than 8"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-6-M-33	6-5/8"	Core: structural clay tile; see notes 15,16,19; Facings: on unexposed side only, see note 18.	n/a	2 hr. 30 min		1		3,5 24	2½
W-6-M-34	6-5/8"	Core: structural clay tile; see notes 15,17,19; Facings: on unexposed side only, see note 18.	n/a	2 hr. 30 min		1		3,5, 24	2½
W-6-M-35	6-5/8"	Core: structural clay tile; see notes 15,16,19; Facings: on fire side only, see note 18.	n/a	2 hr. 30 min		1		3,5, 24	2½
W-6-M-36	6-5/8"	Core: structural clay tile; see notes 15,17,19; Facings: on fire side only, see note 18.	n/a	2 hr. 30 min		1		3,5, 24	2½
W-7-M-37	7"	Cored concrete masonry; see notes 12,34,36,38, 41; See note 35 for facings on both sides.	80 PSI	5 hr.		1		5,25	5
W-7-M-38	7"	Cored concrete masonry; see notes 12,33,36,38, 41; See note 35 for facings.	80 PSI	5 hr.		1		5,25	5
W-7-M-39	7⅛"	Core: structural clay tile; see notes 12,16,20; See note 18 for facings on both sides.	n/a	1 hr. 15 min		1		3,5, 24	1¼
W-7-M-40	7⅛"	Core: structural clay tile; see notes 12,17,20 See note 18 for facings on both sides.	n/a	1 hr. 30 min		1		3,5, 24	1½
W-7-M-41	7⅛"	Core: structural clay tile; see notes 12,16,19; See note 18 for facings on both sides.	n/a	1 hr. 15 min		1		3,5, 24	1¼
W-7-M-42	7⅛"	Core: structural clay tile; see notes 12,17,19; See note 18 for facings on both sides.	n/a	1 hr. 30 min		1		3,5, 24	1½
W-7-M-43	7⅛"	Core: structural clay tile; see notes 13,16,22; Facing: on both sides of wall, see note 18.	n/a	1 hr. 30 min.		1		3,5 24	1½
W-7-M-44	7⅛"	Core: structural clay tile; see notes 13,17,22; Facings: on both sides of wall, see note 18.	n/a	2 hr.		1		3,5, 24	2
W-7-M-45	7⅛"	Core: structural clay tile; see notes 15,16,19 Facings: both sides, see note 18.	n/a	3 hr. 30 min		1		3,5, 24	3½
W-7-M-46	7⅛"	Core: structural clay tile; see notes 15,17,19; Facings: both sides, see note 18.	n/a	3 hr. 30 min		1		3,5 24	3½
W-6-M-47	6"	Core: 5" thick solid gypsum blocks; See note 45; Facings: both sides per note 35.	n/a	6 hr.		1			6
W-6-M-48	6"	Core: hollow concrete units; see notes 47,50, 54; No facings.	n/a	1 hr. 15 min		1			1¼
W-6-M-49	6"	Core: hollow concrete units; see notes 46,50, 54; No facings.	n/a	1 hr. 30 min		1			1½
W-6-M-50	6"	Core: hollow concrete units; see notes 46,41, 54; No facings.	n/a	2 hr.		1			2
W-6-M-51	6"	Core: hollow concrete units; see notes 46,53, 54; No facings.	n/a	3 hr.		1			3
W-6-M-52	6"	Core: hollow concrete units; see notes 47,53, 54; No facings.	n/a	2 hr. 30 min		1			2½
W-6-M-53	6"	Core: hollow concrete units; see notes 47,51, 54; No facings.	n/a	1 hr. 30min.		1			1½
W-6-M-54	6⅛"	Core: hollow concrete units; see notes 46,50, 54; Facing: one side only per note 35.	n/a	2 hr.		1			2
W-6-M-55	6⅛"	Core: hollow concrete units; see notes 4,51,54 Facings: one side per note 35.	n/a	2 hr. 30 min		1			2½

1.1.3 (cont'd)

Wall 6" Thick to Less Than 8"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-6-M-56	6½"	Core: hollow concrete units; see notes 46,53, 54; Facings: one side per note 35.	n/a	4 hrs.		1			4
W-6-M-57	6½"	Core: hollow concrete units; see notes 47,53, 54; Facing: One side per note 35.	n/a	3 hrs.		1			3
W-6-M-58	6½"	Core: hollow concrete units; See notes 47,51, 54; Facing: one side per note 35.	n/a	2 hrs.		1			2
W-6-M-59	6½"	Core: hollow concrete units; see notes 47,50, 54; Facings: one side per note 35.	n/a	1 hr. 45 min		1			1-3/4
W-7-M-60	7"	Core: hollow concrete units; see notes 46,53, 54; Facings: both sides per note 35.	n/a	5 hrs.		1			5
W-7-M-61	7"	Core: hollow concrete units; see notes 46,51, 54; Facings: both sides per note 35.	n/a	3 hrs. 30 min		1			3½
W-7-M-62	7"	Core: hollow concrete units; see notes 46,50, 54; Facings: both sides per note 35.	n/a	2 hrs. 30 min		1			2½
W-7-M-63	7"	Core: hollow concrete units; see notes 47,53, 54; Facing: both sides per note 35.	n/a	4 hrs.		1			4
W-7-M-64	7"	Core: hollow concrete units; see notes 47,51,54 Facing: both sides per note 35.	n/a	2 hrs. 30 min		1			2½
W-7-M-65	7"	Core: hollow concrete units; see notes 47,50, 54; Facing: both sides per note 35.	n/a	2 hrs.		1			2
W-6-M-66	6"	Concrete wall with 4"x4" No. 6 wire fabric(welded) near wall center for reinforcement.	300 PSI	2 hrs. 30 min			43	II	2½

TABLE 1.1.3

NOTES

1. Tested at NBS under ASA Spec. No. 42-1934 (ASTM C-19-53) except that hose stream testing where carried out was run on test specimens exposed for full test duration, not for a reduced period as is contemporarily done.
2. Failure by thermal criteria - maximum temperature rise.
3. For clay tile walls, unless the source of the clay can be positively identified, it is suggested that the most pessimistic hour rating for the fire endurance of a clay tile partition of that thickness be followed. Identified sources of clay showing longer fire endurance can lead to longer time recommendations.
4. See note 55 for construction and design details for clay tile walls.
5. Tested at NBS under ASA Spec. No. A2-1934.
6. Failure mode - collapse.
7. Collapsed on removal from furnace @ 1 hour 9 minutes.
8. Hose stream - failed.
9. Hose stream - passed.
10. No end point met in test.
11. Wall collapsed at 1 hour 28 minutes.

1.1.3 (cont'd)

NOTES

12. One cell in wall thickness.

13. Two cells in wall thickness.

14. Double shells plus one cell in wall thickness.

15. One cell in wall thickness, cells filled with broken tile, crushed stone, slag, cinders or sand mixed with mortar.

16. Dense hard-burned clay or shale tile.

17. Medium-burned clay tile.

18. Not less than 5/8" thickness of 1:3 sanded gypsum plaster.

19. Units of not less than 30% solid material.

20. Units of not less than 40% solid material.

21. Units of not less than 50% solid material.

22. Units of not less than 45% solid material.

23. Units of not less than 60% solid material.

24. All tiles laid in portland cement-lime mortar.

25. Load - 80 PSI for gross cross sectional area of wall.

26. 3 cells in wall thickness.

27. Minimum % of solid material in concrete units = 52.

28. Minimum % of solid material in concrete units = 54.

29. Minimum % of solid material in concrete units = 55.

30. Minimum % of solid material in concrete units = 57.

31. Minimum % of solid material in concrete units = 62.

32. Minimum % of solid material in concrete units = 65.

33. Minimum % of solid material in concrete units = 70.

34. Minimum % of solid material in concrete units = 76.

35. Not less than ½" of 1:3 sanded gypsum plaster.

36. Noncombustible or no members framed into wall.

37. Combustible members framed into wall.

38. 1 unit in wall thickness.

39. 2 units in wall thickness.

40. 3 units in wall thickness.

41. Concrete units made with expanded slag or pumice aggregates.

42. Concrete units made with expanded burned clay or shale, crushed limestone, air cooled slag or cinders.

43. Concrete units made with calcareous sand and gravel. Coarse aggregate, 60% or more calcite and dolomite.

44. Concrete units made with siliceous sand and gravel. 90% or more quartz, chert, or flint.

45. Laid in 1:3 sanded gypsum mortar.

1.1.3 (cont'd)

NOTES

46. Units of expanded slag or pumice aggregate.

47. Units of crushed limestone, blast furnace slag, cinders and expanded clay or shale.

48. Units of calcareous sand and gravel. Coarse aggregate, 60% or more calcite and dolomite.

49. Units of siliceous sand and gravel. 90% or more quartz, chert or flint.

50. Unit minimum 49% solid.

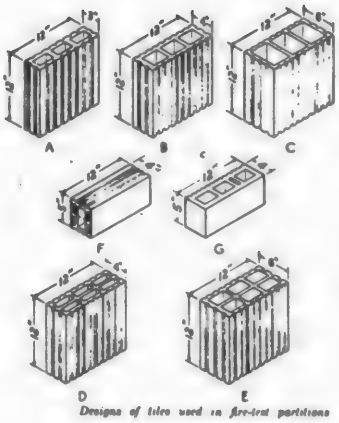
51. Unit minimum 62% solid.

52. Unit minimum 65% solid.

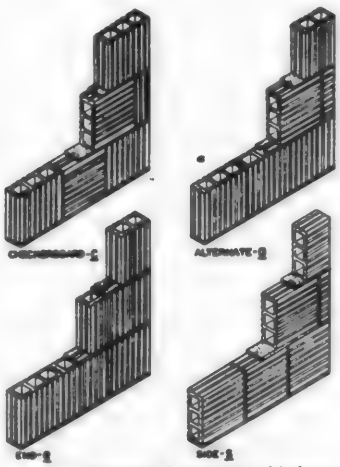
53. Unit minimum 73% solid.

54. Ratings based on 1 unit and 1 cell in wall section.

55. See Clay Tile Partition Design Construction drawings, below.



Designs of tiles used in fire-test partitions



The four types of construction used in fire-test partitions.

FIGURE 1.1.4

WALLS - MASONRY

Thickness - 8" to Less Than 10"

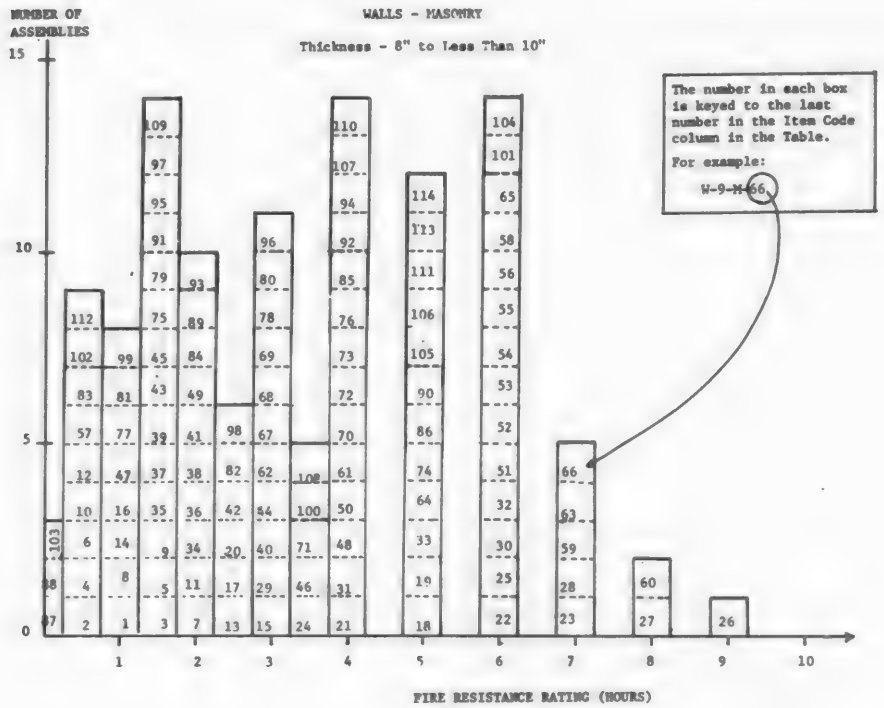


TABLE 1.1.4

MASONRY WALLS

Thickness - 8" to Less Than 10"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-8-M-1	8"	Core: clay or shale structural tile; Units in wall thickness: 1; Cells in wall thickness: 2 Minimum % solids in units: 40.	80 PSI	1 hr. 15min.		1		1, 20	1½
W-8-M-2	8"	Core: clay or shale structural tile; Units in wall thickness: 1; Cell in wall thickness: 2; Minimum % solids in units: 40; Facings: None; Result for wall with combustible members framed into interior.	80 PSI	45min.		1		1, 20	3/4
W-8-M-3	8"	Core: clay or shale structural tile; Units in wall thickness: 1; Cells in wall thickness: 2; Minimum % solids in units: 43.	80 PSI	1 hr. 30min.		1		1, 20	1½
W-8-M-4	8"	Core: clay or shale structural tile: Units in wall thickness: 1; Cells in wall thickness: 2; Minimum % solids in units: 43; No facings; Combustible members framed into wall.	80 PSI	45min.		1		1, 20	3/4
W-8-M-5	8"	Core: clay or shale structural tile; No facings.	See Notes	1 hr. 30min.		1		1,2,5 10,18 20,21	1½
W-8-M-6	8"	Core: Clay or shale structural tile; No facings.	See Notes	45min.		1		1,2,5 10, 19-21	3/4

1.1.4 (cont'd)

Thickness - 8" to Less Than 10"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-8-M-7	8"	Core: clay or shale structural tile; No facings.	See Notes	2 hr.		1		1,2,5 13,18 20,21	2
W-8-M-8	8"	Core: clay or shale structural tile; No facings.	See Notes	1 hr. 15min		1		1,2,5, 13,19, 20,21	1¼
W-8-M-9	8"	Core: clay or shale structural tile; No facings.	See Notes	1 hr. 45min		1		1,2,6, 9,18, 20,21	1-3/4
W-8-M-10	8"	Core: Clay or shale structural tile; No facings.	See Notes	45min		1		1,2,6, 9,19, 20,21	3/4
W-8-M-11	8"	Core: clay or shale structural tile; No facings.	See Notes	2 hr.		1		1,2,6, 10,18, 20,21	2
W-8-M-12	8"	Core: clay or shale structural tile; No facings.	See Notes	45min		1		1,2,6, 10,19, 20,21	3/4
W-8-M-13	8"	Core: clay or shale structural tile; No facings.	See Notes	2 hr. 30min		1		1,3,6, 12,18, 20,21	2½
W-8-M-14	8"	Core: clay or shale structural tile; No facings	See Notes	1 hr.		1		1,2,6, 12,19 20,21	1
W-8-M-15	8"	Core: clay or shale structural tile; No facings.	See Notes	3 hr.		1		1,2,6, 16,18, 20,21	3
W-8-M-16	8"	Core: clay or shale structural tile; No facings.	See Notes	1 hr. 15min		1		1,2,6, 16,19, 20,21	1¼
W-8-M-17	8"	Units in Wall Thickness: 1; Cells in wall thickness: 1; Minimum % solids: 70; Cored clay or shale brick; No facings.	See Notes	2 hr. 30min		1		1, 44	2½
W-8-M-18	8"	Cored clay or shale bricks; Units in wall thickness: 2; Cells in wall thickness: 2; Min. % solids: 87; No facings.	See Notes	5 hr.		1		1,45	5
W-8-M-19	8"	Core: Solid clay or shale brick; No facings.	See Notes	5 hr.		1		1,45 22	5
W-8-M-20	8"	Core: Hollow rolok of clay or shale.	See Notes	2 hr. 30min		1		1,45 22	2½
W-8-M-21	8"	Core: Hollow rolok bak of clay or shale; No facings.	See Notes	4 hr.		1		1,45	4
W-8-M-22	8"	Core: concrete brick; No facings.	See Notes	6 hr.		1		1,45	6
W-8-M-23	8"	Core: sand-lime brick; No facings.	See Notes	7 hr		1		1, 45	7
W-8-M-24	8"	Core: 4", 40% solid clay or shale structural tile; 1 side 4" brick facing;	See Notes	3 hr. 30min		1		1,20	3½
W-8-M-25	8"	Concrete wall (3220 PSI); Reinforcing vertical rods 1" from each face and 1" dia.; horizontal rods 3/8" dia.	22,200 lb/ft.	6 hr.			7		6
W-8-M-26	8"	Core: Sand-lime brick; 1/2" of 1:3 sanded gypsum plaster facing on one side.	See Notes	9 hr.		1		1,45	9
W-8-M-27	8½"	Core: sand-lime brick; ½" of 1:3 sanded gypsum plaster facing on one side.	See Notes	8 hr.		1		1,45	8
W-8-M-28	8½"	Core: concrete; ½" of 1:3 sanded gypsum plaster facing on one side.	See Notes	7 hr.		1		1,45	7
W-8-M-29	8½"	Core: hollow rolok of clay or shale; ½" of 1:3 sanded gypsum plaster facing on one side.	See Notes	3 hr.		1		1,45	3

1.1.4 (cont'd)

Thickness - 8" to Less Than 10"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-8-M-30	8½"	Core: Solid clay or shale brick; ½" thick, 1:3 sanded gypsum plaster facing on one side.	See Notes	6 hr.		1		1,45 22	6
W-8-M-31	8½"	Core: Cored clay or shale brick; Units in wall thickness: 1; Cells in wall thickness: 1; Min. % solids: 70; ½" of 1:3 sanded gypsum plaster facing on both sides.	See Notes	4 hr.		1		1,44	4
W-8-M-32	8½"	Cored clay or shale bricks; Units in wall thickness: 2; Cells in wall thickness: 2; Min. % solids: 87; ½" of 1:3 sanded gypsum plaster facing on one side.	See Notes	6 hr.		1		1,45	6
W-8-M-33	8½"	Hollow Rolok Bak of clay or shale core; ½" of 1:3 sanded gypsum plaster facing on one side.	See Notes	5 hr.		1		1,45	5
W-8-M-34	8-5/8"	Core: clay or shale structural tile; units in wall thickness: 1; cells in wall thickness: 2; Min. % solids in units: 40; 5/8" of 1:3 sanded gypsum plaster facing on one side.	See Notes	2 hr.		1		1,20, 21	2
W-8-M-35	8-5/8"	Core: clay or shale structural tile; units in wall thickness: 1; cells in wall thickness: 2; Min. % solids in units: 40; Exposed face: 5/8" of 1:3 sanded gypsum plaster.	See Notes	1 hr. 30min.		1		1,20, 21	1½
W-8-M-36	8-5/8"	Core: clay or shale structural tile; Units in wall thickness: 1; cells in wall thickness: 2; Min. % solids in units: 43; 5/8" of 1:3 sanded gypsum plaster facing on one side.	See Notes	2 hr.				1,20 21	2
W-8-M-37	8-5/8"	Core: clay or shale structural tile; units in wall thickness: 1; cells in wall thickness: 2; Min. % solids in units: 43; 5/8" of 1:3 sanded gypsum plaster of the exposed face only.	See Notes	1 hr. 30min.		1		1,20 21	1½
W-8-M-38	8-5/8"	Core: clay or shale structural tile; See note 17 for facing side 1.	See Notes	2 hr.		1		1,2,5, 10,18 20,21	2
W-8-M-39	8-5/8"	Core: clay or shale structural tile; Facings: on exposed side only, see note 17.	See Notes	1 hr. 30min.		1		1,2,5, 10,19, 20,21	1½
W-8-M-40	8-5/8"	Core; clay or shale structural tile; Facings on exposed side only, see note 17.	See Notes	3 hr.		1		1,2,5, 13,18, 20,21	3
W-8-M-41	8-5/8"	Core: clay or shale structural tile; Facings on exposed side only, see note 17.	See Notes	2 hr.		1		1,2,5, 13,19, 20,21	2
W-8-M-42	8-5/8"	Core: clay or shale structural tile; facings on side 1, see note 17.	See Notes	2 hr. 30min.		1		1,2,6, 9,18, 20,21	2½
W-8-M-43	8-5/8"	Core: clay or shale structural tile; Facings on exposed side only as per note 17.	See Notes	1 hr. 30min.		1		1,2,6, 9,19, 20,21	1½
W-8-M-44	8-5/8"	Core: clay or shale structural tile ; Facings Side 1: see note 17; Side 2: none.	See Notes	3 hr.		1		1,2,6, 10,18, 20,21	3
W-8-M-45	8-5/8"	Core: Clay or shale structural tile; Facings on fire side only, see note 17.	See Notes	1 hr. 30min		1		1,2,6, 10,19, 20,21	1½
W-8-M-46	8-5/8"	Core: clay or shale structural tile; facings: Side 1: see note 17; Side 2: none.	See Notes	3 hr. 30min.		1		1,2,6, 12,18, 20,21	3½
W-8-M-47	8-5/8"	Core: clay or shale structural tile; Facings exposed side only, see note 17.	See Notes	1 hr. 45min.		1		1,2,6, 12,19, 20,21	1-3/4
W-8-M-48	8-5/8"	Core: clay or shale structural tile; Facings: Side 1: See note 17; Side 2: None.	See Notes	4 hr.		1		1,2,6, 16,18, 20,21	4
W-8-M-49	8-5/8"	Core: clay or shale structural tile; Facings: fire side only, see note 17.	See Notes	2 hr.		1		1,2,6, 16,19, 20,21	2

1.1.4 (cont'd)

Thickness - 8" to Less Than 10"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-8-M-50	8-5/8"	Core: 4", 40% solid clay or shale structural tile; 4" brick plus 5/8" of 1:3 sanded gypsum plaster facing on one side.	See Notes	4 hr.		1		1,20	4
W-8-M-51	8-3/4"	8-3/4"x 2½" and 4"x 2½" Cellular fletton (1873 PSI) single and triple cell hollow bricks set in ½" sand mortar in alt. courses.	3.6 ton/ foot	6 hr.			7	23,29	6
W-8-M-52	8-3/4"	8-3/4" thick cement brick (2527 PSI) with P.C. and sand mortar.	3.6 ton/ft	6 hr.			7	23,24	6
W-8-M-53	8-3/4"	8-3/4"x 2½" fletton brick (1831 PSI) in ½" sand mortar.	3.6 ton/ft	6 hr.			7	23,24	6
W-8-M-54	8-3/4"	8-3/4"x 2½" London stock brick (683 PSI) in ½" P.C.-sand mortar	7.2 ton/ft	6 hr.			7	23,24	6
W-9-M-55	9"	9"x 2½" Leicester Red Wire cut brick(4465 PSI) in ½" P.C. - sand mortar.	6.0 ton/ft	6 hr.			7	24,23	6
W-9-M-56	9"	9"x 3" sandlime brick (2603 PSI) in ½" P.C. sand mortar.	3.6 ton/ft	6 hr.			7	23,24	6
W-9-M-57	9"	2 layers 2-7/8 fletton brick (1910 PSI) with 3½" air space; Cement and sand mortar.	1.5 ton/ft	32min.			7	23,25	1/3
W-9-M-58	9"	9"x 3" stairfoot brick (7527 PSI) in ½" sand-cement mortar.	7.2 ton/ft	6 hr.			7	23,24	6
W-9-M-59	9"	Core: Solid clay or shale bricks; ½" thick; 1:3 sanded gypsum plaster facing on both sides	See Notes	7 hr.		1		1,45 22	7
W-9-M-60	9"	Core: Concrete brick; ½" of 1:3 sanded gypsum plaster facings on both sides.	See Notes	8 hr.		1		1,45	8
W-9-M-61	9"	Core: Hollow Rolok of clay or shale; ½" of 1:3 sanded gypsum plaster facings on both sides.	See Notes	4 hr.		1		1,45	4
W-9-M-62	9"	Cored clay or shale brick; Units in wall thickness: 1; cells in wall thickness: 1; Min. % solids: 70; ½" of 1:3 sanded gypsum plaster facing on one side.	See Notes	3 hr.		1		1,44	3
W-9-M-63	9"	Cored clay or shale bricks; Units in wall thickness: 2; cells in wall thickness: 2; Min. % solids: 87; ½" of 1:3 sanded gypsum plaster facing on both sides.	See Notes	7 hr.		1		1,45	7
W-9-M-64	9-10"	Core: Cavity wall of clay or shale brick; No facings.	See Notes	5 hr.		1		1,45	5
W-9-M-65	9"-10"	Core: Cavity construction of clay or shale brick; ½" of 1:3 sanded gypsum plaster facing on one side.	See Notes	6 hr.		1		1,45	6
W-9-M-66	9"-10"	Core: Cavity construction of clay or shale brick; ½" of 1:3 sanded gypsum plaster facing on both sides.	See Notes	7 hr.		1		1,45	7
W-9-M-67	9¼"	Core: clay or shale structural tile; Units in wall thickness: 1; cells in wall thickness: 2; Min.% solids in units: 40; 5/8" of 1:3 sanded gypsum plaster facing on both sides.	See Notes	3 hr.		1		1,20, 21	3
W-9-M-68	9¼"	Core: Clay or shale structural tile; Units in wall thickness: 1; cells in wall thickness: 2; Min. % solids in units: 43; 5/8" of 1:3 sanded gypsum plaster facings on both sides.	See Notes	3 hr.		1		1,20 21	3
W-9-M-69	9¼"	Core: clay or shale structural tile; Facings: Side 1: See note 17; Side 2: See note 17.	See Notes	3 hr.		1		1,2,5 10,18 20,21	3
W-9-M-70	9¼"	Core: clay or shale structural tile; Facings: Side 1 and 2: See note 17.	See Notes	4 hr.		1		1,2,5 13,18 20,21	4
W-9-M-71	9¼"	Core: clay or shale structural tile; Facings: Side 1 and 2: See note 17.	See Notes	3 hr. 30min.		1		1,2,6, 9,18, 20,21	3½

1.1.4 (cont'd)

Thickness - 8" to Less Than 10"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-9-M-72	9⅛"	Core: clay or shale structural tile; Facings: Side 1 and 2: See note 17.	See Notes	4 hr.		1		1,2,6, 10,18, 20,21	4
W-9-M-73	9⅛"	Core: clay or shale structural tile; Facings: Side 1 and 2: See note 17.	See Notes	4 hr.		1		1,2,6, 12,18, 20,21	4
W-9-M-74	9⅛"	Core: clay or shale structural tile; Facings: Side 1 and 2: See note 17.	See Notes	5 hr.		1		1,2,6, 16,18, 20,21	5
W-8-M-75	8"	Cored concrete masonry; See notes 2,19,26,34,40 No facings.	80 PSI	1 hr. 30 min		1		1,20	1½
W-8-M-76	8"	Cored concrete masonry; See notes 2,18,26,34,40 No facings.	80 PSI	4 hrs.		1		1,20	4
W-8-M-77	8"	Cored concrete masonry; See notes 2,26,31,19,40 No facings.	80 PSI	1 hr. 15 min		1		1,20	1¼
W-8-M-78	8"	Cored concrete masonry; See notes 2,18,26,31,40 No facings.	80 PSI	3 hrs.		1		1,20	3
W-8-M-79	8"	Cored concrete masonry; See notes 2,19,26,36,41 No facings.	80 PSI	1 hr. 30 min		1		1,20	1½
W-8-M-80	8"	Cored concrete masonry; See notes 2,26,36,18,41 No facings.	80 PSI	3 hrs.		1		1,20	3
W-8-M-81	8"	Cored concrete masonry; See notes 2,19,26,34,41 No facings.	80 PSI	1 hr.		1		1,20	1
W-8-M-82	8"	Cored concrete masonry; See notes 2,18,26,34,41 No facings.	80 PSI	2 hrs. 30 min		1		1,20	2½
W-8-M-83	8"	Cored concrete masonry: See notes 2,19,26,29,41 No facings.	80 PSI	45 min		1		1,20	3/4
W-8-M-84	8"	Cored concrete masonry; See notes 2,18,26,29,41 No facings.	80 PSI	2 hrs.		1		1,20	2
W-8-M-85	8½"	Cored concrete masonry; See notes 3,18,26,34,41 Facings: 2¼" brick.	80 PSI	4 hrs.		1		1,20	4
W-8-M-86	8"	Cored concrete masonry; See notes 3,18,26,34,41 Facings: 3-3/4" brick face.	80 PSI	5 hrs.		1		1,20	5
W-8-M-87	8"	Cored concrete masonry; See notes 2,19,26,30,43 No facings.	80 PSI	12 min		1		1,20	1/5
W-8-M-88	8"	Cored concrete masonry; See notes 2,18,26,30,43 No facings.	80 PSI	12 min		1		1,20	1/5
W-8-M-89	8½"	Cored concrete masonry; See notes 2,19,26,34,40 Facings: on fire side only; see note 38.	80 PSI	2 hrs.		1		1,20	2
W-8-M-90	8½"	Cored concrete masonry; See notes 2,18,26,34,40 Facings: see note 38 for side 1.	80 PSI	5 hrs.		1		1,20	5
W-8-M-91	8½"	Cored concrete masonry; See notes 2,26,31,19, 40; Facings on fire side only; see note 38.	80 PSI	1 hr. 45min		1		1,20	1-3/4
W-8-M-92	8½"	Cored concrete masonry; See notes 2,26,18,31, 40; Facings on one side; see note 38.	80 PSI	4 hrs		1		1,20	4
W-8-M-93	8½"	Cored concrete masonry; See notes 2,19,26,36, 41; Facings on fire side only; see note 38.	80 PSI	2 hrs		1		1,20	2
W-8-M-94	8½"	Cored concrete masonry; see notes 2,18,26,36, 41; Facings on fire side only; see note 38.	80 PSI	4 hrs		1		1,20	4
W-8-M-95	8½"	Cored concrete masonry; See notes 2,19,26,34, 41; Facings on fire side only; see note 38.	80 PSI	1 hr. 30min		1		1,20	1½
W-8-M-96	8½"	Cored concrete masonry; See notes 2,26,34,18, 41; Facings on one side; see note 38.	80 PSI	3 hrs		1		1,20	3
W-8-M-97	8½"	Cored concrete masonry; See notes 2,19,26,29, 41; Facings on fire side only; see note 38.	80 PSI	1 hr. 30min		1		1,20	1½

1.1.4 (cont'd)

Thickness - 8" to Less Than 10"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec. Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-8-M-98	8½"	Cored concrete masonry; See notes 2,18,26,29, 41; Facings on one side; see note 38.	80 PSI	2 hrs 30min		1		1,20	2½
W-8-M-99	8½"	Cored concrete masonry; See notes 3,19,23,27, 41; No facings.	80 PSI	1 hr. 15min		1		1,20	1¼
W-8-M-100	8½"	Cored concrete masonry; See notes 3,18,23,27, 41; No facings.	80 PSI	3 hrs 30min		1		1,20	3½
W-8-M-101	8½"	Cored concrete masonry; See notes 3,18,26,34,41 Facings 3-3/4" brick face; one side only; see note 38.	80 PSI	6 hrs		1		1,20	6
W-8-M-102	8½"	Cored concrete masonry; See notes 2,19,26,30, 43; Facings on fire side only; see note 38.	80 PSI	30min.		1		1,20	½
W-8-M-103	8½"	Cored concrete masonry; See notes 2,18,26,30, 43; Facings on one side only; see note 38.	80 PSI	12min.		1		1,20	1/5
W-9-M-104	9"	Cored concrete masonry; see notes 2,18,26,34,40 Facings on both sides; see note 38.	80 PSI	6 hrs.		1		1,20	6
W-9-M-105	9"	Cored concrete masonry; See notes 2,18,26,31,40 Facings on both sides; see note 38.	80 PSI	5 hrs.		1		1,20	5
W-9-M-106	9"	Cored concrete masonry; See notes 2,18,26,36,41 Facings on both sides of wall; see note 38.	80 PSI	5 hrs.		1		1,20	5
W-9-M-107	9"	Cored concrete masonry; See notes 2,18,26,34,41 Facings on both sides; see note 38.	80 PSI	4 hrs.		1		1,20	4
W-9-M-108	9"	Cored concrete masonry; See notes 2,18,26,29,41 Facings on both sides; See note 38.	80 PSI	3 hrs. 30min.		1		1,20	3½
W-9-M-109	9"	Cored concrete masonry; See notes 3,19,23,27,40 Facing on fire side only; see note 38.	80 PSI	1 hr. 45min.		1		1,20	1-3/4
W-9-M-110	9"	Cored concrete masonry; See notes 3,18,27,23,41 Facings on one side only; see note 38.	80 PSI	4 hrs.		1		1,20	4
W-9-M-111	9"	Cored concrete masonry; See notes 3,18,26,34,41 2½" brick face on one side only; see note 38.	80 PSI	5 hrs.		1		1,20	5
W-9-M-112	9"	Cored concrete masonry; See notes 2,18,26,30,43 Facings on both sides; see note 38.	80 PSI	30min.		1		1,20	½
W-9-M-113	9½"	Cored concrete masonry; See notes 3,18,23,27,41 Facings on both sides; see note 38.	80 PSI	5 hrs.		1		1,20	5
W-8-M-114	8"		100 PSI	5 hrs.			43	22	5

TABLE 1.1.4

NOTES

1. Tested at NBS under ASA Spec. No. 42-1934 (ASTM C-19-53)
2. 1 unit in wall thickness.
3. 2 units in wall thickness.
4. 2 or 3 units in wall thickness.
5. 2 cells in wall thickness.
6. 3 or 4 cells in wall thickness.
7. 4 or 5 cells in wall thickness.
8. 5 or 6 cells in wall thickness.
9. Minimum % of solid materials in units: 40%.

1.1.4 (cont'd)

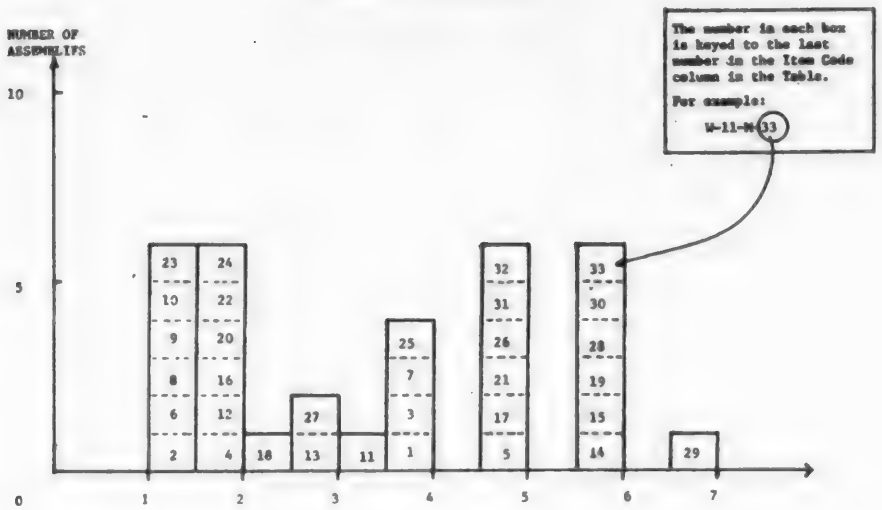
Notes

10. Minimum % of solid materials in units: 43%.
11. Minimum % of solid materials in units: 46%.
12. Minimum % of solid materials in units: 48%.
13. Minimum % of solid materials in units: 49%.
14. Minimum % of solid materials in units: 45%.
15. Minimum % of solid materials in units: 51%.
16. Minimum % of solid materials in units: 53%.
17. Not less than 5/8" thickness of 1:3 sanded gypsum plaster.
18. Non combustible or no members framed into wall.
19. Combustible members framed into wall.
20. Load: 80 PSI for gross cross sectional area of wall.
21. Portland cement lime mortar.
22. Failure mode thermal.
23. British test.
24. Passed all criteria.
25. Failed by sudden collapse with no preceding signs of impending failure.
26. 1 cell in wall thickness.
27. 2 cells in wall thickness.
28. 3 cells in wall thickness.
29. Minimum % of solid material in concrete units = 52.
30. Minimum % of solid material in concrete units = 54.
31. Minimum % of solid material in concrete units = 55.
32. Minimum % of solid material in concrete units = 57.
33. Minimum % of solid material in concrete units = 60.
34. Minimum % of solid material in concrete units = 62.
35. Minimum % of solid material in concrete units = 65.
36. Minimum % of solid material in concrete units = 70.
37. Minimum % of solid material in concrete units = 76.
38. Not less than ½" of 1:3 sanded gypsum plaster.
39. 3 units in wall thickness.
40. Concrete units made with expanded slag or pumice aggregates.
41. Concrete units made with expanded burned clay or shale, crushed limestone, air cooled slag or cinders.
42. Concrete units made with calcareous sand and gravel. Coarse aggregate, 60% or more calcite and dolomite.
43. Concrete units made with siliceous sand and gravel. 90% or more quartz, chert and dolomite.
44. Load: 120 psi for gross cross-sectional area of wall.
45. Load: 160 psi for gross corss-sectional area of wall.

FIGURE 1.1.5

WALLS - MASONRY

Thickness - 10" To Less Than 12"



FIRE RESISTANCE RATING (HOURS)

TABLE 1.1.5

WALLS - MASONRY

Thickness - 10" to Less Than 12"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-10-M-1	10"	Core: Two, 3-3/4", 40% solid clay or shale structural tiles with 2" air space between; Facings: 3/4" portland cement plaster or stucco on both sides.	80 PSI	4 hrs		1		1,20	4
W-10-M-2	10"	Core: Cored concrete masonry, 2" air cavity; See notes 27,34,19,3,40; Facings: None.	80 PSI	1 hr. 30min		1		1,20	1½
W-10-M-3	10"	Cored concrete masonry; See notes 27,34,18,3, 40; Facings: None.	80 PSI	4 hrs		1		1,20	4
W-10-M-4	10"	Cored concrete masonry; See notes 26,33,19,2, 40; Facings: None.	80 PSI	2 hrs		1		1,20	2
W-10-M-5	10"	Cored concrete masonry; See notes 26,33,18,2, 40; No facings.	80 PSI	5 hrs		1		1,20	5
W-10-M-6	10"	Cored concrete masonry; See notes 26,33,19,2, 41; No facings.	80 PSI	1 hr. 30min		1		1,20	1½
W-10-M-7	10"	Cored concrete masonry; See notes 26,33,18,2, 41; No facings.	80 PSI	4 hrs		1		1,20	4
W-10-M-8	10"	Cored concrete masonry (cavity type 2" air space) See notes 27,34,19,3,42; No facings.	80 PSI	1 hr. 15min		1		1,20	1¼
W-10-M-9	10"	Cored concrete masonry (cavity type 2" air space); See notes 3, 27,34,18,42; No facings.	80 PSI	1 hr. 15 min		1		1,20	1¼
W-10-M-10	10"	Cored concrete masonry (cavity type 2" air space) See notes 3,19,27,34,41; No facings.	80 PSI	1 hr. 15 min		1		1,20	1¼
W-10-M-11	10"	Cored concrete masonry (cavity type 2" air space) See notes 3,18,27,34,41; No facings	80 PSI	3 hrs 30 min		1		1,20	3½

1.1.5 (cont'd)

Thickness - 10" to Less Than 12"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-10-M-12	10"	9" thick concrete block (11-3/4"x 9"x 4½") with 2 - 2" thick voids included; 3/8" P.C. plaster 1/8" neat gypsum.	n/a	1 hr. 53 min			7	23,44	1-3/4
W-10-M-13	10"	Hollow clay tile block wall - 8½" block with 2 - 3" voids in each 8½" section; 3/4" gypsum plaster - each face.	n/a	2 hrs. 42 min			7	23,25	2½
W-10-M-14	10"	2 layers 4½" brick with 1½" air space - no ties sand cement mortar. (Fletton brick - 1910 PSI)	n/a	6 hrs.			7	23,24	6
W-10-M-15	10"	2 layers 4½" thick Fletton brick - 1910 PSI brick; 1½" air space; Ties - 18" O.C. vertical; 3' O.C. - horizontal.	n/a	6 hrs.			7	23,24	6
W-10-M-16	10½"	Cored concrete masonry; 2" air cavity; See note 3,19,27,34,40; Facings: Fire side only; See note 38.	80 PSI	2 hrs.		1		1,20	2
W-10-M-17	10½"	Cored concrete masonry; See notes 3,27,34,18,40 Facings: Only side one; See note 38.	80 PSI	5 hrs.		1		1,20	5
W-10-M-18	10½"	Cored concrete masonry; See notes 2,19,26,33, 40; Facings on fire side only; See note 38.	80 PSI	2 hrs 30min.		1		1,20	2½
W-10-M-19	10½"	Cored concrete masonry; See notes 2,18,26,33, 40; Facings on one side; See note 38.	80 PSI	6 hrs.		1		1,20	6
W-10-M-20	10½"	Cored concrete masonry; See notes 2,19,26,33, 41; Facing on fire side of wall only; See note 38.	80 PSI	2 hrs.		1		1,20	2
W-10-M-21	10½"	Cored concrete masonry; See notes 2,18,26,33, 41; Facings on one side only; See note 38.	80 PSI	5 hrs.		1		1,20	5
W-10-M-22	10½"	Cored concrete masonry (cavity type 2" air space); See notes 3,19,27,34,42; Facing on fire side only; See note 38.	80 PSI	1 hr. 45min.		1		1,20	1-3/4
W-10-M-23	10½"	Cored concrete masonry (cavity type 2" air space); See notes 3,18,27,34,42; Facings on one side only; See note 38.	80 PSI	1 hr. 15min.		1		1,20	1¼
W-10-M-24	10½"	Cored concrete masonry (cavity type 2" air space); See notes 3,27,34,19,41; Facings on fire side only; See note 38.	80 PSI	2 hrs.		1		1,20	2
W-10-M-25	10½"	Cored concrete masonry (cavity type 2" air space); See notes 3,18,27,34,41; Facings on one side only; See note 38.	80 PSI	4 hrs.		1		1,20	4
W-10-M-26	10-5/8"	Core: 8", 40% solid tile plus 2" furring tile. 5/8" sanded gypsum plaster between tile types; Facings on both sides 3/4" portland cement plaster or stucco.	80PSI	5 hrs.		1		1,20	5
W-10-M-27	10-5/8"	Core: 8", 40% solid tile plus 2" furring tile. 5/8" sanded gypsum plaster between tile types. Facings on one side 3/4" portland cement plaster or stucco.	80 PSI	3 hrs 30min.		1		1,20	3½
W-11-M-28	11"	Cored concrete masonry; See notes 3,18,27,34, 40; Facings on both sides; See note 38.	80 PSI	6 hrs.		1		1,20	6
W-11-M-29	11"	Cored concrete masonry; See notes 2,18,26,33, 40; Facings on both sides; See note 38.	80 PSI	7 hrs.		1		1,20	7
W-11-M-30	11"	Cored concrete masonry; See notes 2,18,26,33, 41; Facings on both sides of wall; See note 38	80 PSI	6 hrs.		1		1,20	6
W-11-M-31	11"	Cored concrete masonry (cavity type 2" air space); See notes 3,18,27,34,42; Facings on both sides; See note 38.	80 PSI	5 hrs.		1		1,20	5
W-11-M-32	11"	Cored concrete masonry (cavity type 2" air space). See notes 3,18,27,34,41; Facings on both sides; See note 38.	80 PSI	5 hrs.		1		1,20	5
W-11-M-33	11"	2 layers brick (4½" flettom 2428 PSI) 2" air space; Galv. ties - 18" O.C. - Horizontal; 3' O.C. - Vertical.	3 ton/ ft.	6 hrs.			7	23,24	6

TABLE 1.1.5

NOTES

1. Tested at NBS - ASA Spec. A2-1934.
2. One unit in wall thickness.
3. Two units in wall thickness.
4. Two or three units in wall thickness.
5. Two cells in wall thickness.
6. Three or four cells in wall thickness.
7. Four or five cells in wall thickness.
8. Five or six cells in wall thickness.
9. Minimum % of solid materials in units: 40%.
10. Minimum % of solid materials in units: 43%.
11. Minimum % of solid materials in units: 46%.
12. Minimum % of solid materials in units: 48%.
13. Minimum % of solid materials in units: 49%.
14. Minimum % of solid materials in units: 45%.
15. Minimum % of solid materials in units: 51%.
16. Minimum % of solid materials in units: 53%.
17. Not less than 5/8" thickness of 1:3 sanded gypsum plaster.
18. Non-combustible or no members framed into wall.
19. Combustible members framed into wall.
20. Load: 80PSI for gross cross sectional area.
21. Portland cement - lime mortar.
22. Failure mode - thermal.
23. British test.
24. Passed all criteria.
25. Failed by sudden collapse with no preceding signs of impending failure.
26. One cell in wall thickness.
27. Two cells in wall thickness.
28. Three cells in wall thickness.
29. Minimum % of solid material in concrete units: 52%.
30. Minimum % of solid material in concrete units: 54%.
31. Minimum % of solid material in concrete units: 55%.
32. Minimum % of solid material in concrete units: 57%.
33. Minimum % of solid material in concrete units: 60%.
34. Minimum % of solid material in concrete units: 62%.
35. Minimum % of solid material in concrete units: 65%.
36. Minimum % of solid material in concrete units: 70%.
37. Minimum % of solid material in concrete units: 76%.
38. Not less than ½" of 1:3 sanded gypsum plaster.
39. Three units in wall thickness.
40. Concrete units made with expanded slag or pumice aggregates.
41. Concrete units made with expanded burned clay or shale, crushed limestone, air cooled slag or cinders.
42. Concrete units made with calcareous sand and gravel. Coarse aggregate, 60% or more calcite and dolomite.

FIGURE 1.1.6

WALLS - MASONRY

Thickness - 12" "o Less Than 14"

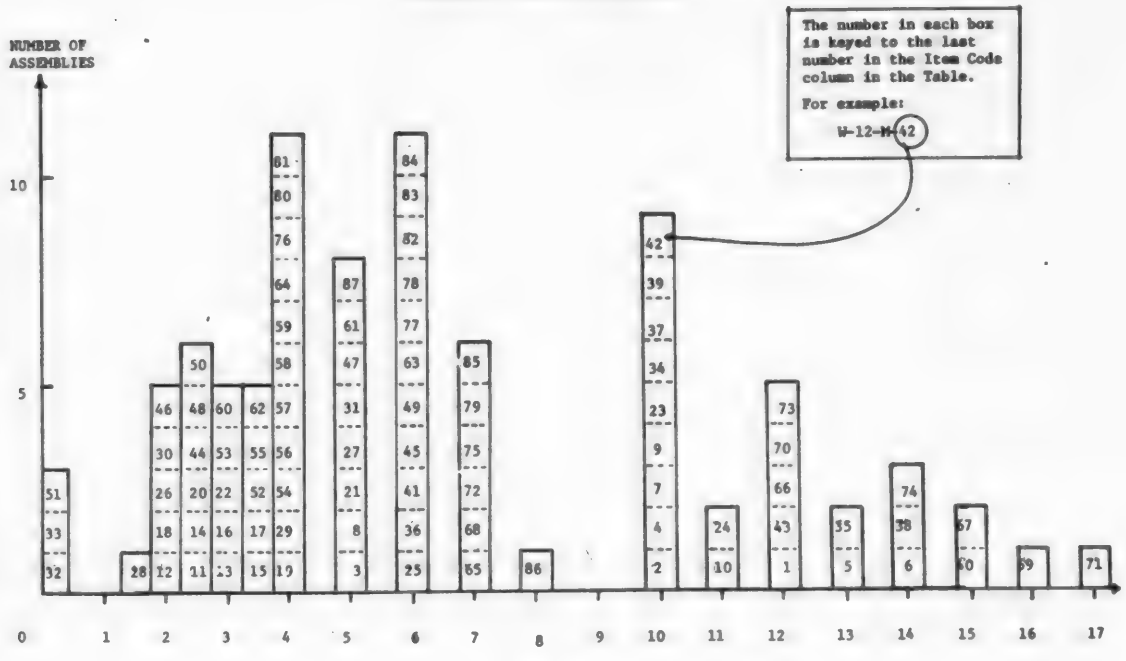

The number in each box is keyed to the last number in the Item Code column in the Table.
For example:
W-12-M-42
NUMBER OF ASSEMBLIES
FIRE RESISTANCE RATING (HOURS)

TABLE 1.1.6

WALLS - MASONRY

Thickness - 12" to Less Than 14"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-12-M-1	12"	Core: Solid clay or shale brick; No facings.	n/a	12 hr		1		1	12
W-12-M-2	12"	Core: Solid clay or shale brick; No facings.	160 PSI	10 hr		1		1,44	10
W-12-M-3	12"	Core: Hollow Rolok of clay or shale; No facings	160 PSI	5 hr.		1		1,44	5
W-12-M-4	12"	Core: Hollow Rolok Bak of Clay or Shale; No facings.	160 PSI	10 hr		1		1,44	10
W-12-M-5	12"	Core: Concrete brick; No facings.	160 PSI	13 hr		1		1,44	13
W-12-M-6	12"	Core: Sand-lime brick; No facings.	n/a	14 hr		1		1	14
W-12-M-7	12"	Core: Sand-lime brick; No facings.	160 PSI	10 hr		1		1,44	10
W-12-M-8	12"	Cored clay or shale bricks; Units in wall thickness: 1; Cells in wall thickness: 2; Min. % solids: 70; No facings.	120 PSI	5 hr.		1		1,45	5
W-12-M-9	12"	Cored clay or shale bricks; Units in wall thickness: 3; Cells in wall thickness: 3; Min. % solids: 87; No facings.	160 PSI	10 hr		1		1,44	10
W-12-M-10	12"	Cored clay or shale bricks; Units in wall thickness:3; Cells in wall thickness: 3; Min. % solids: 87; No facings.	n/a	11 hr		1		1	11
W-12-M-11	12"	Core: Clay or shale structural tile; See notes 2,6,9,18; No facings.	80 PSI	2½ hr.		1		1,20	2½
W-12-M-12	12"	Core: Clay or shale structural tile; See notes 2,4,9,19; No facings.	80 PSI	2 hr.		1		1,20	2

1.1.6 (cont'd)

Thickness - 12" to Less Than 14"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-12-M-13	12"	Core: Clay or shale structural tile; See notes 2,6,14,19; No facings.	80 PSI	3 hr.		1		1,20	3
W-12-M-14	12"	Core: Clay or shale structural tile; See notes 2,6,14,18; No facings.	80 PSI	2½ hr.		1		1,20	2½
W-12-M-15	12"	Core: Clay or shale structural tile; See notes 2,4,13,18; No facings.	80 PSI	3½hr.		1		1,20	3½
W-12-M-16	12"	Core: Clay or shale structural tile; See notes 2,4,13,19; No facings.	80 PSI	3 hr.		1		1,20	3
W-12-M-17	12"	Core: Clay or shale structural tile; See notes 3,6,9,18; No facings.	80 PSI	3½ hr.		1		1,20	3½
W-12-M-18	12"	Core: Clay or shale structural tile; See notes 3,6,9,19; No facings.	80 PSI	2 hr.		1		1,20	2
W-12-M-19	12"	Core: Clay or shale structural tile; See notes 3,6,14,18; No facings.	80 PSI	4 hr.		1		1,20	4
W-12-M-20	12"	Core: Clay or shale structural tile; See notes 3,6,14,19; No facings.	80 PSI	2½ hr.		1		1,20	2½
W-12-M-21	12"	Core: Clay or shale structural tile; See notes 3,6,16,18; No facings.	80 PSI	5 hr.		1		1,20	5
W-12-M-22	12"	Core: Clay or shale structural tile; See notes 3,6,16,19; No facings.	80 PSI	3 hr.		1		1,20	3
W-12-M-23	12"	Core: 8", 70% solid clay or shale structural tile; 4" brick facing on one side.	80 PSI	10 hr.		1		1,20	10
W-12-M-24	12"	Core: 8", 70% solid clay or shale structural tile; 4" brick facing on one side.	n/a	11 hr.		1		1	11
W-12-M-25	12"	Core: 8", 40% solid clay or shale structural tile; 4" brick facing on one side.	80 PSI	6 hr.		1		1,20	6
W-12-M-26	12"	Cored concrete masonry; See notes 1,9,15,16 & 20; No facings.	80 PSI	2 hr.		1		1,20	2
W-12-M-27	12"	Cored concrete masonry; See notes 26,34,18,2,41 No facings.	80 PSI	5 hr.		1		1,20	5
W-12-M-28	12"	Cored concrete masonry; See notes 26,31,19,2, 41; No facings.	80 PSI	1½ hr.		1		1,20	1½
W-12-M-29	12"	Cored concrete masonry; See notes 26,31,18,2, 41; No facings.	80 PSI	4 hr.		1		1,20	4
W-12-M-30	12"	Cored concrete masonry; See notes 27,31,19,3, 43; No facings.	80 PSI	2 hr.		1		1,20	2
W-12-M-31	12"	Cored concrete masonry; See notes 27,31,18,3, 43; No facings.	80 PSI	5 hr.		1		1,20	5
W-12-M-32	12"	Cored concrete masonry; See notes 26,32,19,2, 43; No facings.	80 PSI	25 min.		1		1,20	1/3
W-12-M-33	12"	Cored concrete masonry; See notes 26,32,18,2, 43; No facings.	80 PSI	25 min.		1		1,20	1/3
W-12-M-34	12½"	Core: Solid clay or shale brick; ½" of 1:3 sanded gypsum plaster facing on one side.	160 PSI	10 hr.		1		1,44	10
W-12-M-35	12½"	Core: Solid clay or shale brick; ½" of 1:3 sanded gypsum plaster facing on one side	n/a	13 hr.		1		1	13
W-12-M-36	12½"	Core: Hollow Rolock of clay or shale; ½" of 1:3 sanded gypsum plaster facing on one side.	160 PSI	6 hr.		1		1,44	6
W-12-M-37	12½"	Core: Hollow Rolok Bak of clay or shale; ½" of 1:3 sanded gypsum plaster facing on one side.	160 PSI	10 hr.		1		1,44	10
W-12-M-38	12½"	Core: Concrete; ½" of 1:3 sanded gypsum plaster facing on one side.	160 PSI	14 hr.		1		1,44	14
W-12-M-39	12½"	Core: Sand-lime brick; ½" of 1:3 sanded gypsum plaster facing on one side.	160 PSI	10 hr.		1		1,44	10
W-12-M-40	12½"	Core: Sand-lime brick; ½" of 1:3 sanded gypsum plaster facing on one side.	n/a	15 hr.		1		1	15

1.1.6 (cont'd)

Thickness - 12" to Less Than 14"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-12-M-41	12½"	Units in wall thickness: 1; Cells in wall thickness: 2; Min. % solids: 70; Cored clay or shale brick; ½" of 1:3 sanded gypsum plaster facing on one side.	120 PSI	6 hr.		1		1,45	6
W-12-M-42	12½"	Cored clay or shale bricks; Units in wall thickness: 3; Cells in wall thickness: 3; Min. % solids: 87; ½" of 1:3 sanded gypsum plaster facings on one side.	160 PSI	10 hr.		1		1,44	10
W-12-M-43	12½"	Cored clay or shale bricks; Units in wall thickness: 3; Cells in wall thickness: 3; Min. % solids: 87; ½" of 1:3 sanded gypsum plaster facing on one side.	n/a	12 hr.		1		1	11
W-12-M-44	12½"	Cored concrete masonry; See notes 26,34.19,2,41 Facing on fire side only - See note 38.	80 PSI	2½ hr.		1		1,20	2½
W-12-M-45	12½"	Cored concrete masonry; See notes 26,34,18,39,241; Facing on one side only - See note 38.	80 PSI	6 hr.		1		1,20	6
W-12-M-46	12½"	Cored concrete masonry; See notes 26,31,19,2,41 Facing on fire side only - see note 38.	80 PSI	2 hr.		1		1,20	2
W-12-M-47	12½"	Cored concrete masonry; See notes 26,31,18,2,41 Facings one side of wall only - See note 38.	80 PSI	5 hr.		1		1,20	5
W-12-M-48	12½"	Cored concrete masonry; See notes 27,31,19,3,43 Facing on fire side only - See note 38.	80 PSI	2½ hr.		1		1,20	2½
W-12-M-49	12½"	Cored concrete masonry; See notes 27,31,18,3, 43; Facing one side only - See note 38.	80 PSI	6 hr.		1		1,20	6
W-12-M-50	12½"	Cored concrete masonry; See notes 26,32,19,2,43 Facing on fire side only - See note 38.	80 PSI	2½ hr.		1		1,20	2½
W-12-M-51	12½"	Cored concrete masonry; See notes 26,32,18,2,43 Facing one side only - See note 38.	80 PSI	25 min		1		1,20	1/3
W-12-M-52	12-5/8"	Clay or shale structural tile; See notes 2,6,9, 18; Facing: Side 1 - See note 17; Side 2: none	80 PSI	3½ hr.		1		1,20	3½
W-12-M-53	12-5/8"	Clay or shale structural tile; See notes 2,6,9, 19; Facing on fire side only; See note 17.	80 PSI	3 hr.		1		1,20	3
W-12-M-54	12-5/8"	Clay or shale structural tile; See notes 2,6, 14, 19; Facing: Side 1 - See note 17; Side 2 - none.	80 PSI	4 hr.		1		1,20	4
W-12-M-55	12-5/8"	Clay or shale structural tile; See notes 2,6, 14,18; Facings on exposed side only - See note 17.	80 PSI	3½ hr.		1		1,20	3½
W-12-M-56	12-5/8"	Clay or shale structural tile; See notes 2,4, 13,18; Facings: Side 1 - See note 17; Side 2 - None	80 PSI	4 hr.		1		1,20	4
W-12-M-57	12-5/8"	Clay or shale structural tile; See notes 1,4, 13,19; Facings on fire side only; See note 17.	80 PSI	4 hr.		1		1,20	4
W-12-M-58	12-5/8"	Clay or shale structural tile; See notes 3,6,9 18; Facings: Side 1 - See note 17; Side 2: none	80 PSI	4 hr.		1		1,20	4
W-12-M-59	12-5/8"	Clay or shale structural tile; See notes 3,6,9, 19; Facings on fire side only - See note 17.	80 PSI	3 hr.		1		1,20	3
W-12-M-60	12-5/8"	Clay or shale structural tile; See notes 3,6, 14,18; Facings: Side 1 - See note 17; Side 2: None.	80 PSI	5 hr.		1		1,20	5
W-12-M-61	12-5/8"	Clay or shale structural tile; See notes 3,6, 14,19; Facings: fire side only; See note 17.	80 PSI	3 hr 30min.		1		1,20	3½
W-12-M-62	12-5/8"	Clay or shale structural tile; See notes: 3,6, 16,18; Facings: Side 1 - See note 17; Side 2 - None.	80 PSI	6 hr.		1		1,20	6
W-12-M-63	12-5/8"	Clay or shale structural tile; See notes 3, 6, 16,19; Facings on fire side only; See note 17.	80 PSI	4 hr.		1		1,20	4
W-12-M-64	12-5/8"	Core: 8", 40% solid clay or shale structural tile; Facings 4" brick plus 5/8" of 1:3 sanded gypsum plaster on one side.	80 PSI	7 hr.		1		1,20	7

1.1.6 (cont'd)

Thickness - 12" to Less Than 14"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-13-M-65	13"	Core: Solid clay or shale brick; ½" of 1:3 sanded gypsum plaster facing on both sides.	160 PSI	12 hr.		1		1,44	12
W-13-M-66	13"	Core: Solid clay or shale brick; ½" of 1:3 sanded gypsum plaster facing on both sides.	n/a	15 hr.		1		1,20	15
W-13-M-67	13"	Core: Solid clay or shale brick; ½" of 1:3 sanded gypsum plaster facings on both sides.	n/a	15 hr.		1		1	15
W-13-M-68	13"	Core: Hollow Rolok of clay or shale; ½" of 1:3 sanded gypsum plaster facings on both sides.	80 PSI	7 hr.		1		1,20	7
W-13-M-69	13"	Core: Concrete brick; ½" of 1:3 sanded gypsum plaster facings on both sides.	160 PSI	16 hr.		1		1,44	16
W-13-M-70	13"	Core: Sand-lime brick; ½" of 1:3 sanded gypsum plaster facings on both sides.	160 PSI	12 hr.		1		1,44	12
W-13-M-71	13"	Core: Sand-lime brick; ½" of 1:3 sanded gypsum plaster facings on both sides.	n/a	17 hr.		1		1	17
W-13-M-72	13"	Cored clay or shale bricks; units in wall thickness: 1; Cells in wall thickness: 2; Min. % solids: 70; ½" of 1:3 sanded gypsum plaster facings on both sides.	120 PSI	7 hr.		1		1,45	7
W-13-M-73	13"	Cored clay or shale bricks; Units in wall thickness: 3; Cells in wall thickness: 3; Min. % solids: 87; ½" of 1:3 sanded gypsum plaster facings on both sides.	160 PSI	12 hr.		1		1,44	12
W-13-M-74	13"	Cored clay or shale bricks; Units in wall thickness: 3; Cells in wall thickness: 2; Min. % solids: 87; ½" of 1:3 sanded gypsum plaster facings on both sides.	n/a	14 hr.		1		1	14
W-13-M-75	13"	Cored concrete masonry; See notes 28,23,18,39, 41; No facings.	80 PSI	7 hr.		1		1,20	7
W-13-M-76	13"	Cored concrete masonry; See notes 28,23,19,39, 41; No facings	80 PSI	4 hr.		1		1,20	4
W-13-M-77	13"	Cored concrete masonry; See notes 27,31,18,3, 43; Facings on both sides; See note 38.	80 PSI	6 hr.		1		1,20	6
W-13-M-78	13"	Cored concrete masonry; See notes 26,31,18,2, 41; Facings on both sides; See note 38.	80 PSI	6 hr.		1		1,20	6
W-13-M-79	13"	Cored concrete masonry; See notes 26,34,18,2, 41; Facings on both sides of wall; See note 38.	80 PSI	7 hr.		1		1,20	7
W-13-M-80	13¼"	Core: Clay or shale structural tile: See notes 2,6,9,18; Facings: See note 17 for both sides.	80 PSI	4 hr.		1		1,20	4
W-13-M-81	13¼"	Core: Clay or shale structural tile; See notes 2,6,14,19; Facings: See note 17 for both sides.	80 PSI	4 hr.		1		1,20	4
W-13-M-82	13¼"	Core: Clay or shale structural tile; See notes 2,4,13,18; Facings: See note 17 for both sides.	80 PSI	6 hr.		1		1,20	6
W-13-M-83	13¼"	Core: Clay or shale structural tile; See notes 3,6,9,18; Facings: See note 17 for both sides.	80 PSI	6 hr.		1		1,20	6
W-13-M-84	13¼"	Core: Clay or shale structural tile; See notes 3,6,14,18; Facings: See note 17 for both sides.	80 PSI	6 hr.		1		1,20	6
W-13-M-85	13¼"	Core: Clay or shale structural tile; See notes 3,6,16,18; Facings: See note 17 for both sides.	80 PSI	7 hr.		1		1,20	7
W-13-M-86	13½"	Cored concrete masonry; See notes 28,23,18,39, 41; Facing on one side only; See note 38.	80 PSI	8 hr.		1		1,20	8
W-13-M-87	13½"	Cored concrete masonry; See notes 28,23,19,39, 41; Facing on fire side only; See note 38.	80 PSI	5 hr.		1		1,20	5

TABLE 1.1.6

NOTES

1. Tested at NBS - ASA Spec. A2-1934.
2. One unit in wall thickness.
3. Two units in wall thickness.
4. Two or three units in wall thickness.
5. Two cells in wall thickness.
6. Three or four cells in wall thickness.
7. Four or five cells in wall thickness.
8. Five or six cells in wall thickness.
9. Minimum % of solid materials in units: 40%.
10. Minimum % of solid materials in units: 43%.
11. Minimum % of solid materials in units: 46%.
12. Minimum % of solid materials in units: 48%.
13. Minimum % of solid materials in units: 49%.
14. Minimum % of solid materials in units: 45%.
15. Minimum % of solid materials in units: 51%.
16. Minimum % of solid materials in units: 53%.
17. Not less than 5/8" thickness of 1:3 sanded gypsum plaster.
18. Non-combustible or no members framed into wall.
19. Combustible members framed into wall.
20. Load: 80PSI for gross area.
21. Portland cement - lime mortar.
22. Failure mode - thermal.
23. British test.
24. Passed all criteria.
25. Failed by sudden collapse with no preceding signs of impending failure.
26. One cell in wall thickness.
27. Two cells in wall thickness.
28. Three cells in wall thickness.
29. Minimum % of solid material in concrete units: 52%.
30. Minimum % of solid material in concrete units: 54%.
31. Minimum % of solid material in concrete units: 55%.
32. Minimum % of solid material in concrete units: 57%.
33. Minimum % of solid material in concrete units: 60%.
34. Minimum % of solid material in concrete units: 62%.
35. Minimum % of solid material in concrete units: 65%.
36. Minimum % of solid material in concrete units: 70%.
37. Minimum % of solid material in concrete units: 76%.
38. Not less than ½" of 1:3 sanded gypsum plaster.
39. Three units in wall thickness.
40. Concrete units made with expanded slag or pumice aggregates.
41. Concrete units made with expanded burned clay or shale, crushed limestone, air cooled slag or cinders.
42. Concrete units made with calcareous sand and gravel. Coarse aggregate, 60% or more calcite and dolomite.
43. Concrete units made with siliceous sand and gravel. 90% or more quartz, chert, or flint.
44. Load: 160 psi of gross wall cross-sectional area.
45. Load: 120 psi of gross wall cross-sectional area.

FIGURE 1.1.7

WALLS - MASONRY

Thickness - 14" or More

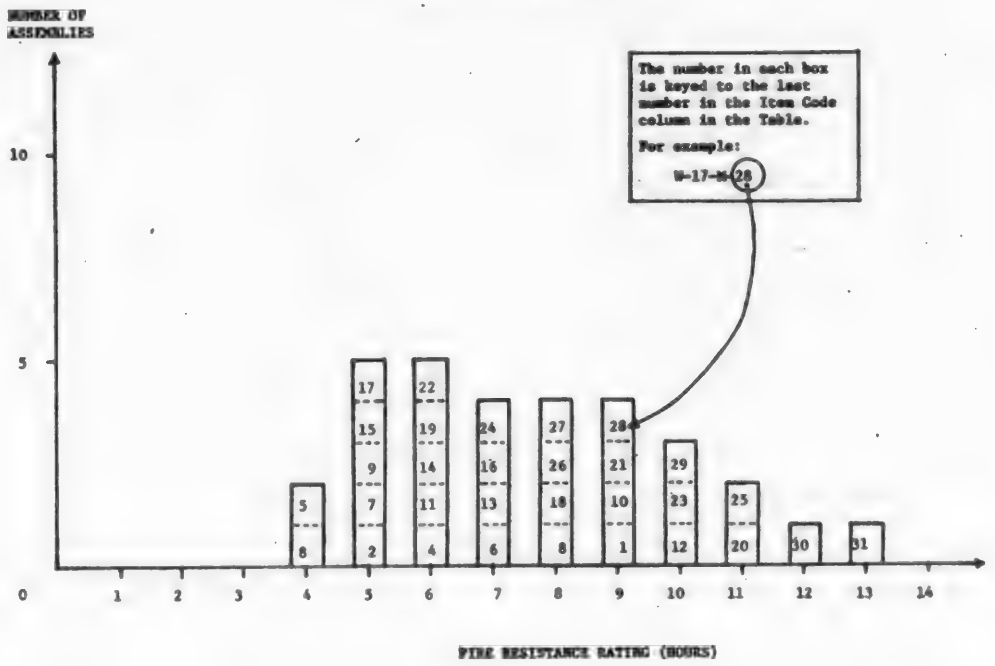


TABLE 1.1.7

WALLS - MASONRY

Walls - 14" or More Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-14-M-1	14"	Core: Cored concrete masonry; See notes 18,28, 35,39,41; Facings: Both sides, see note 38.	80 PSI	9 hr.		1		1,20	9
W-16-M-2	16"	Core: Clay or shale structural tile; See notes 4,7,9,19; No facings.	80 PSI	5 hr.		1		1,20	5
W-16-M-3	16"	Core: Clay or shale structural tile; See notes 4,7,9,19; No facings.	80 PSI	4 hr.		1		1,20	4
W-16-M-4	16"	Core: Clay or shale structural tile: See notes 4,7,10,18; No facings.	80 PSI	6 hr.		1		1,20	6
W-16-M-5	16"	Core: Clay or shale structural tile; See notes 4,7,10,19; No facings.	80 PSI	4 hr.		1		1,20	4
W-16-M-6	16"	Core: Clay or shale structural tile; See notes 4,7,11,18; No facings.	80 PSI	7 hr.		1		1,20	7
W-16-M-7	16"	Core: Clay or shale structural tile; See notes 4,7,11,19; No facings.	80 PSI	5 hr.		1		1,20	5
W-16-M-8	16"	Core: Clay or shale structural tile; See notes 4,8,13,18; No facings.	80 PSI	8 hr.		1		1,20	8
W-16-M-9	16"	Core: Clay or shale structural tile; See notes 4,8,13,19; No facings.	80 PSI	5 hr.		1		1,20	5

1.1.7 (cont'd)

Walls - 14" or More Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-16-M-10	16"	Clay or shale structural tile core; see notes 4,8,15,18; No facings.	80 PSI	9 hr.		1		1,20	9
W-16-M-11	16"	Clay or shale structural tile core; See notes 3,7,14,18; No facings.	80 PSI	6 hr.		1		1,20	6
W-16-M-12	16"	Clay or shale structural tile core; See notes 4,8,16,18; No facings.	80 PSI	10 hr.		1		1,20	10
W-16-M-13	16"	Clay or shale structural tile core; See notes 4,6,16,19; No facings.	80 PSI	7 hr.		1		1,20	7
W-16-M-14	16-5/8"	Clay or shale structural tile core; See notes 4,7,9,18; Facings: Side 1 - See note 17; Side 2 None.	80 PSI	6 hr.		1		1,20	6
W-16-M-15	16-5/8"	Clay or shale structural tile core; See notes 4,7,9,19; Facings: Fire side only; See note 17.	80 PSI	5 hr.		1		1,20	5
W-16-M-16	16-5/8"	Clay or shale structural tile core; See notes 4,7,10,18; Facings:Side 1-See note 17; Side 2-None.	80 PSI	7 hr.		1		1,20	7
W-16-M-17	16-5/8"	Clay or shale structural tile core; See notes 4,7,10,19; Facings: Fire side only; See note 17.	80 PSI	5 hr.		1		1,20	5
W-16-M-18	16-5/8"	Clay or shale structural tile core; See notes 4,7,11,18; Facings: Side 1-See note 17; Side 2 None.	80 PSI	8 hr.		1		1,20	8
W-16-M-19	16-5/8"	Clay or shale structural tile core; See notes 4,7,11,19; Facings: Fire side only; See note 17.	80 PSI	6 hr.		1		1,20	6
W-16-M-20	16-5/8"	Clay or shale structural tile core; See notes 4,8,13,18; Facings: Side 1-See note 17; Side 2-Same as side 1.	80 PSI	11 hr.		1		1,20	11
W-16-M-21	16-5/8"	Clay or shale structural tile core; See notes 4,8,13,18; Facings: Side 1-See note 17; Side 2 None.	80 PSI	9 hr.		1		1,20	9
W-16-M-22	16-5/8"	Clay or shale structural tile core; See notes 4,8,13,19; Facings: Fire side only; See note 17.	80 PSI	6 hr.		1		1,20	6
W-16-M-23	16-5/8"	Clay or shale structural tile core; See notes 4,8,15,18; Facings: Side 1-See note 17; Side 2 None.	80 PSI	10 hr.		1		1,20	10
W-16-M-24	16-5/8"	Clay or shale structural tile core; See notes 4,8,15,19; Facings: Fire side only; See note 17.	80 PSI	7 hr.		1		1,20	7
W-16-M-25	16-5/8"	Clay or shale structural tile core; See notes 4,6,16,18; Facings: Side 1-See note 17; Side 2-None	80 PSI	11 hr.		1		1,20	11
W-16-M-26	16-5/8"	Clay or shale structural tile core; See notes 4,6,16,19; Facings: Fire side only. see note 17.	80 PSI	8 hr.		1		1,20	8
W-17-M-27	17⅛"	Clay or shale structural tile core; See notes 4,7,9,18; Facings: Side 1 & 2 - See note 17.	80 PSI	8 hr.		1		1,20	8
W-17-M-28	17⅛"	Clay or shale structural tile core; See notes 4, 7,10,18; Facings: Side 1 & 2: See note 17.	80 PSI	9 hr.		1		1,20	9
W-17-M-29	17⅛"	Clay or shale structural tile core; See notes 4, 7,11,18; Facings: Side 1 & 2: See note 17.	80 PSI	10 hr.		1		1,20	10
W-17-M-30	17⅛"	Clay or shale structural tile core; See notes 4, 8,15,18; Facings: Side 1 & 2: See note 17.	80 PSI	12 hr.		1		1,20	12
W-17-M-31	17⅛"	Clay or shale structural tile core; See notes 4, 6,16,18; Facings: Side 1 & 2: See note 17.	80 PSI	13 hr.		1		1,20	13

1.1.7

NOTES

1. Tested at NBS - ASA Spec. A2-1934.
2. One unit in wall thickness.
3. Two units in wall thickness.
4. Two or three units in wall thickness.
5. Two cells in wall thickness.
6. Three or four cells in wall thickness.
7. Four or five cells in wall thickness.
8. Five or six cells in wall thickness.
9. Minimum % of solid materials in units: 40%.
10. Minimum % of solid materials in units: 43%.
11. Minimum % of solid materials in units: 46%.
12. Minimum % of solid materials in units: 48%.
13. Minimum % of solid materials in units: 49%.
14. Minimum % of solid materials in units: 45%.
15. Minimum % of solid materials in units: 51%.
16. Minimum % of solid materials in units: 53%.
17. Not less than 5/8" thickness of 1:3 sanded gypsum plaster.
18. Non-combustible or no members framed into wall.
19. Combustible members framed into wall.
20. Load: 80 PSI for gross area.
21. Portland cement - lime mortar.
22. Failure mode - thermal.
23. British test.
24. Passed all criteria.
25. Failed by sudden collapse with no preceding signs of impending failure.
26. One cell in wall thickness.
27. Two cells in wall thickness.
28. Three cells in wall thickness.
29. Minimum % of solid material in concrete units: 52%.
30. Minimum % of solid material in concrete units: 54%.
31. Minimum % of solid material in concrete units: 55%.
32. Minimum % of solid material in concrete units: 57%.
33. Minimum % of solid material in concrete units: 60%.
34. Minimum % of solid material in concrete units: 62%.
35. Minimum % of solid material in concrete units: 65%.
36. Minimum % of solid material in concrete units: 70%.
37. Minimum % of solid material in concrete units: 76%.
38. Not less than ½" of 1:3 sanded gypsum plaster.
39. Three units in wall thickness.
40. Concrete units made with expanded slag or pumice aggregates.
41. Concrete units made with expanded burned clay or shale, crushed limestone, air cooled slag or cinders.
42. Concrete units made with calcareous sand and gravel. Coarse aggregate, 60% or more calcite and dolomite.
43. Concrete units made with siliceous sand and gravel. 90% or more quarts, chert, or flint.

FIGURE 1.2.1

WALLS - METAL FRAME

Thickness 0" To Less Than 4"

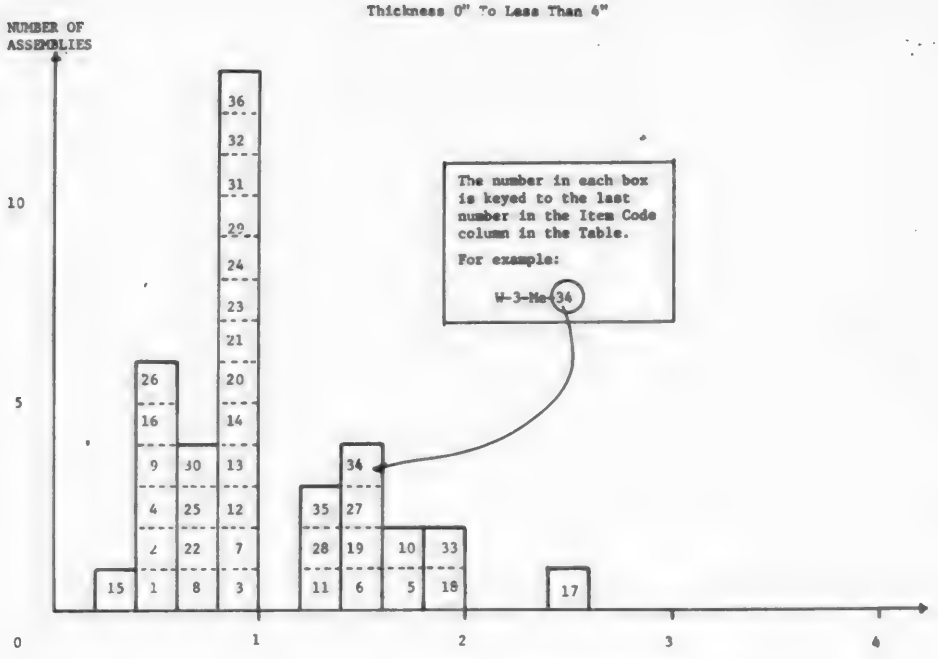


TABLE 1.2.1

WALLS - METAL FRAME

Thickness 0" to Less Than 4"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-3-Me-1	3"	Core: Steel channels having 3 rows of 4"x 1/8" staggered slots in web. Core filled with heat expanded vermiculite weighing 1.5 lb/ft^2 of wall area; Facings: Side 1 - 18 gage steel, spot welded to core; Side 2 - Same as side 1.	n/a	25min		1			1/3
W-3-Me-2	3"	Core: Steel channels having 3 rows of 4"x 1/8" staggered slots in web; core filled with heat expanded vermiculite weighing 2 lb/ft^2 of wall area; Facings: Side 1 and 2 - 18 gage steel, spot welded to core.	n/a	30min		1			½
W-2-Me-3	2½"	Solid partition - 3/8" tension rods (vertical) 3' O.C. with metal lath; Scratch coat - cement/sand/lime plaster; float coats - cement/sand/lime plaster; finish coats - neat gypsum plaster.	n/a	1 hr.			7	1	1
W-2-Me-4	2"	Solid wall: steel channel per note 1, 2" thickness of 1:2, 1:3 portland cement on metal lath.	n/a	30min.		1			½
W-2-Me-5	2"	Solid wall: steel channel per note 1, 2" thickness of neat gypsum plaster on metal lath.	n/a	1 hr. 45 min		1			1-3/4
W-2-Me-6	2"	Solid wall: steel channel per note 1, 2" thickness of 1:½, 1:½ gypsum plaster on metal lath.	n/a	1 hr. 30 min		1			1½

1.2.1 (cont'd)

Thickness 0" to Less Than 4"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-2-Me-7	2"	Solid wall: steel channel per note 2, 2" thickness of 1:1, 1:1 gypsum plaster on metal lath.	n/a	1 hr.		1			1
W-2-Me-8	2"	Solid wall: steel channel per note 1, 2" thickness of 1:2, 1:2 gypsum plaster on metal lath.	n/a	45 min		1			3/4
W-2-Me-9	2¼"	Solid wall: steel channel per note 2, 2¼" thickness of 1:2, 1:3 portland cement on metal lath	n/a	30 min		1			½
W-2-Me-10	2¼"	Solid wall: steel channel per note 2, 2¼" thickness of neat gypsum plaster on metal lath.	n/a	2 hrs.		1			2
W-2-Me-11	2¼"	Solid wall: steel channel per note 2, 2¼" thickness of 1:½, 1:½ gypsum plaster on metal lath.	n/a	1 hr. 45 min		1			1-3/4
W-2-Me-12	2¼"	Solid wall: steel channel per note 2, 2¼" thickness of 1:1, 1:1 gypsum plaster on metal lath.	n/a	1 hr. 15 min		1			1½
W-2-Me-13	2¼"	Solid wall: steel channel per note 2, 2¼" thickness of 1:2, 1:2 gypsum plaster on metal lath.	n/a	1 hr.		1			1
W-2-Me-14	2½"	Solid wall: steel channel per note 1; 2½" thickness of 4.5:1:7, 4.5:1:7 portland cement, sawdust, and sand sprayed on wire mesh.(see note 3 for wire mesh).	n/a	1 hr.		1			1
W-2-Me-15	2½"	Solid wall: steel channel per note 2; 2½" thickness of 1:4, 1:4 portland cement spray on wire mesh (per note 3).	n/a	20 min		1			1/3
W-2-Me-16	2½"	Solid Wall: steel channel per note 2, 2½" thickness of 1:2, 1:3 portland cement on metal lath	n/a	30min		1			½
W-2-Me-17	2½"	Solid wall: steel channel per note 2, 2½" thickness of neat gypsum plaster on metal lath.	n/a	2 hr. 30 min		1			2½
W-2-Me-18	2½"	Solid wall: steel channel per note 2, 2½" thickness of 1:½, 1:½ gypsum plaster on metal lath.	n/a	2 hr.		1			2
W-2-Me-19	2½"	Solid wall: steel channel per note 2, 2½" thickness of 1:1, 1:1 gypsum plaster on metal lath.	n/a	1 hr. 30min		1			1½
W-2-Me-20	2½"	Solid wall: steel channel per note 2, 2½" thickness of 1:2, 1:2, gypsum plaster on metal lath.	n/a	1 hr.		1			1
W-2-Me-21	2½"	Solid wall: steel channel per note 2, 2½" thickness of 1:2, 1:3 gypsum plaster on metal lath.	n/a	1 hr.		1			1
W-3-Me-22	3"	Core: steel channels per note 2, 1:2, 1:2 gypsum plaster on 3/4" soft asbestos lath, plaster thickness 2".	n/a	45min		1			3/4
W-3-Me-23	3½"	Solid wall: steel channel per note 2, 2½" thickness of 1:2, 1:2 gypsum plaster on 3/4" asbestos lath.	n/a	1 hr.		1			1
W-3-Me-24	3½"	Solid wall: steel channel per note 2, lath over and 1:2½, 1:2½ gypsum plaster on 1" magnesium oxysulfate wood fiberboard, plaster thickness 2½".	n/a	1 hr.		1			1

1.2.1 (cont'd)

Thickness 0" to Less than 4"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-3-Me-25	3½"	Core: steel studs, note 4; Facings 3/4" thickness of 1:1/30:2, 1:1/30:3 portland cement and asbestos fiber plaster.	n/a	45min.		1			3/4
W-3-Me-26	3½"	Core: steel studs, note 4; Facings: both sides 3/4" thickness of 1:2, 1:3 portland cement.	n/a	30min.		1			½
W-3-Me-27	3½"	Core: steel studs per note 4; Facings: both sides 3/4" thickness of neat gypsum plaster.	n/a	1 hr. 30min.		1			1½
W-3-Me-28	3½"	Core: steel studs per note 4; Facings: both sides 3/4" thickness of 1:¼, 1:½ gypsum plaster.	n/a	1 hr. 15min.		1			1¼
W-3-Me-29	3½"	Core: steel studs, note 4; Facings: both sides 3/4" thickness of 1:2, 1:2 gypsum plaster.	n/a	1 hr.		1			1
W-3-Me-30	3½"	Core: steel studs, note 4; Facings: both sides 3/4" thickness of 1:2, 1:3 gypsum plaster.	n/a	45min.		1			3/4
W-3-Me-31	3-3/4"	Core: steel studs, note 4; Facings: both sides 7/8" thickness of 1:1/30:2, 1:1/30:3 portland cement and asbestos fiber plaster.	n/a	1 hr.		1			1
W-3-Me-32	3-3/4"	Core: steel studs, note 4; Facings: both sides 7/8" thickness of 1:2, 1:3 portland cement.	n/a	45 min		1			3/4
W-3-Me-33	3-3/4"	Core: steel studs, note 4; Facings: both sides 7/8" thickness of neat gypsum plaster.	n/a	2 hr.		1			2
W-3-Me-34	3-3/4"	Core: steel studs per note 4; Facings: both sides 7/8" thickness of 1:¼, 1:½ gypsum plaster.	n/a	1 hr. 30min.		1			1½
W-3-Me-35	3-3/4"	Core: steel studs per note 4; Facings: both sides 7/8" thickness of 1:2, 1:2 gypsum plaster	n/a	1 hr. 15min		1			1¼
W-3-Me-36	3-3/4"	Core: steel per note 4; Facings: 7/8" thickness of 1:2, 1:3 gypsum plaster on both sides.	n/a	1 hr.		1			1

TABLE 1.2.1

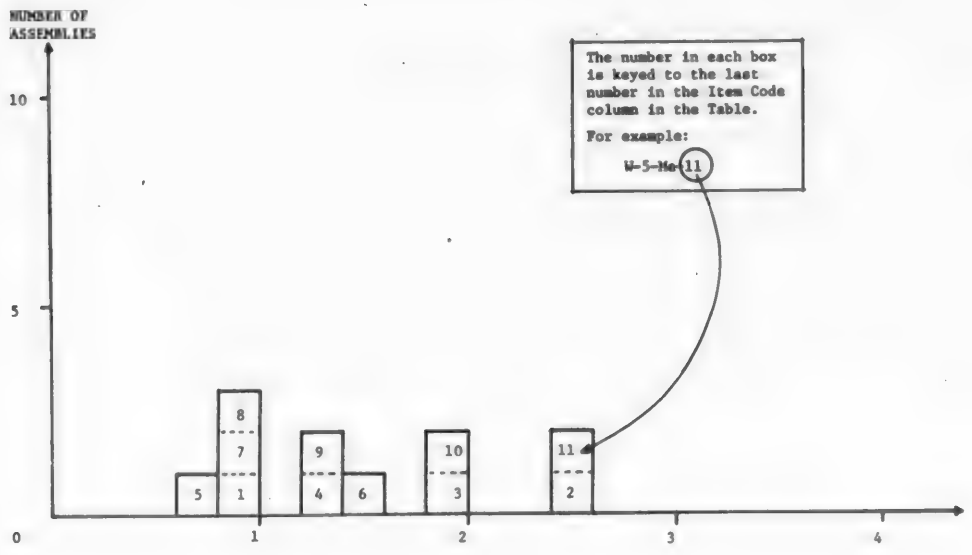
NOTES

1. Failure mode - local temperature rise - back face.
2. 3/4" or 1" channel framing - hot-rolled or strip-steel channels.
3. Reinforcement is 4" square mesh of No. 6 wire welded at intersections (no channels).
4. Ratings are for any usual type of non-load-bearing metal framing providing 2"(or more) air space.

FIGURE 1.2.2

WALLS - METAL FRAME

Thickness 4" To Less Than 6"



FIRE RESISTANCE RATING (HOURS)

TABLE 1.2.2

WALLS - METAL FRAME

Thickness 4" to Less Than 6"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-5-Me-1	5½"	3" cavity with 16 ga. channel studs (3½' O.C.) of ½"x ½" channel and 3" spacer. Metal lath on ribs with plaster (3 coats) 3/4" over face of lath. Plaster (each side) - scratch coat - cement/lime/sand with hair; float coat - cement/lime/sand; finish coat - neat gypsum.	n/a	1 hr. 11min.			7	1	1
W-4-Me-2	4"	Core: Steel studs per note 2; Facings: Both sides 1" thickness of neat gypsum plaster.	n/a	2½ hr.		1			2½
W-4-Me-3	4"	Core: Steel studs, note 2; Facings: both sides 1" thickness of 1:¼, 1:½ gypsum plaster.	n/a	2 hr.		1			2
W-4-Me-4	4"	Core: Steel per note 2; Facings: Both sides 1" thickness of 1:2, 1:3 gypsum plaster.	n/a	1¼ hr.		1			1¼
W-4-Me-5	4½"	Core: Lightweight steel stud 3" in depth; Facings: Both sides 3/4" thick sanded gypsum plaster, 1:2 scratch coat, 1:3 brown coat applied on metal lath.	See Note 4	45min.		1		5	3/4
W-4-Me-6	4½"	Core: lightweight steel studs 3" in depth; Facings: both sides 3/4" thick neat gypsum plaster on metal lath.	See Note 4	1 hr. 30min.		1		5	1½

1.2.2 (cont'd)

Thickness 4" to Less Than 6"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-4-Me-7	4½"	Core: lightweight steel studs 3" in depth; Facings: both sides 3/4" thick sanded gypsum plaster, 1:2 scratch and brown coats applied over metal lath.	See Note 4	1 hr.		1		5	1
W-4-Me-8	4-3/4"	Core: lightweight steel studs 3" in depth; Facings: both sides 7/8" thick sanded gypsum plaster, 1:2 scratch, 1:3 brown, applied over metal lath.	See Note 4	1 hr.		1		5	1
W-4-Me-9	4-3/4"	Core: lightweight steel studs 3" in depth; Facings: both sides 7/8" thick sanded gypsum plaster 1:2 scratch and brown coats applied on metal lath.	See Note 4	1 hr. 15 min		1		5	1¼
W-5-Me-10	5"	Core: lightweight steel studs 3" in depth; Facings: both sides 1" thick neat gypsum plaster on metal lath.	See Note 4	2 hr.		1		5	2
W-5-Me-11	5"	Core: lightweight steel studs 3" in depth; Facings: both sides 1" thick neat gypsum plaster on metal lath.	See Note 4	2 hr. 30min.		1		5,6	2½

TABLE 1.2.2

NOTES

1. Failure mode - local back face temperature rise.
2. Ratings are for any usual type of non-bearing metal framing providing a minimum 2" air space.
3. Facing materials secured to lightweight steel studs not less than 3" deep.
4. Rating based on loading to develop a maximum stress of 7270 PSI for net area of each stud.
5. Spacing of steel studs must be sufficient to develop adequate rigidity in the metal-lath or gypsum-plaster base.
6. As per note 4 but load/stud not to exceed 5120 PSI.

TABLE 1.2.3

WALLS - METAL FRAME

Thickness - 6" to Less Than 8"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-6-Me-1	6-5/8"	On one side of 1" magnesium oxysulfate wood fiberboard sheathing attached to steel studs (see notes 1 and 2), 1" air space, and 3-3/4" brick secured with metal ties to steel frame every fifth course; Inside facing of 7/8" 1:2 sanded gypsum plaster on metal lath secured directly to studs; Plaster side exposed to fire.	See Note 2	1-3/4 hour		1		1	1-3/4
W-6-Me-2	6-5/8"	On one side, of 1" magnesium oxysulfate wood fiberboard sheathing attached to steel studs (see notes 1 and 2), 1" air space, and 3-3/4" brick secured with metal ties to steel frame every 5th course. Inside facing of 7/8" 1:2 sanded gypsum plaster on metal lath secured directly to studs; Brick face exposed to fire.	See Note 2	4 hr.		1		1	4
W-6-Me-3	6-5/8"	On one side of 1" magnesium oxysulfate wood fiberboard sheathing attached to steel studs (see notes 1 and 2), 1" air space, and 3-3/4" brick secured with metal ties to steel frame every 5th course. Inside facing of 7/8" vermiculite plaster on metal lath secured directly to studs. Plaster side exposed to fire.	See Note 2	2 hr.		1		1	2

TABLE 1.2.3

NOTES

1. Lightweight steel studs (minimum 3" deep) used. Stud spacing dependent on loading, but in each case, spacing is to be such that adequate rigidity is provided to the metal lath plaster base.

2. Load is such that stress developed in studs is not greater than 5120 PSI calculated from net stud area.

TABLE 1.2.4

WALLS - METAL FRAME

Thickness - 8" to Less Than 10"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-9-Me-1	9-1/16"	On one side of ½" wood fiberboard sheathing next to studs, 3/4" air space formed with 3/4" x 1-5/8" wood stripe placed over the fiberboard and secured to the studs; paper backed wire lath nailed to stripe 3-3/4" brick veneer held in place by filling a 3/4" space between the brick and paper backed lath with mortar. Inside facing of 3/4" neat gypsum plaster on metal lath attached to 5/16" plywood strips secured to edges of steel studs. Rated as combustible because of the sheathing. See notes 1 and 2. Plaster exposed.	See Note 2	1½ hr		1		1	1½
W-9-Me-2	9-1/16"	Same as above with brick exposed.	See Note 2	4 hr.		1		1	4
W-8-Me-3	8½"	On one side, of paper backed wire lath attached to studs and 3-3/4" brick veneer held in place by filling a 1" space between the brick and lath with mortar. Inside facing of 1" paper-enclosed mineral wool blanket weighing .6 lb/ft^2 attached to studs, metal lath or paper backed wire lath laid over the blanket and attached to the studs, and 3/4" sanded gypsum plaster 1:2 for the scratch and 1:3 for the brown coat. (See notes 1 and 2.) Plaster face exposed.	See Note 2	4 hr.		1		1	4
W-8-Me-4	8½"	Same as above with brick exposed.	See Note 2	5 hr.		1		1	5

TABLE 1.2.4

NOTES

1. Lightweight steel studs $\geq$ 3" in depth. Stud spacing is dependent upon loading but in any case the spacing is to be such that adequate rigidity is provided to the metal-lath plaster base.

2. Load is such that the stress developed in the steel studs is $\leq$ 5,120 psi calculated from the net area of the stud.

TABLE 1.3.1

WOOD FRAME WALLS

Walls 0" to Less Than 4" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-3-W-1	3-3/4	Solid Wall - 2½" Wood-Wool Slab Core; 3/4" Gypsum Plaster Each Side	N/A	2 hrs			7	1	2
W-3-W-2	3-7/8"	2 x 4 stud wall, 3/16" thick cement asbestos board on both sides of wall.	360PSI net area	10 min		1		2-5	1/6
W-3-W-3	3-7/8"	Same as W-3-W1 but stud cavities filled with 1 lb/ft^2 mineral wool bats.	360PSI net area	40 min		1		2-5	2/3

TABLE 1.3.1

NOTES

1. Achieved "Grade C" Fire Resistance (British).
2. Nominal 2 x 4 wood studs of No. 1 Common or better lumber set edgewise, 2 x 4 plates at top and bottom and blocking at mid-height of wall.
3. All horizontal joints in facing material backed by 2 x 4 blocking in wall.
4. Load = 360 psi of net stud cross-sectional area.
5. Facings secured with 6 d casing nails. Nail holes predrilled and 0.02"- 0.03" smaller than nail diameter.

FIGURE 1.3.2

WOOD FRAME WALLS

Walls 4" To Less Than 6" Thick

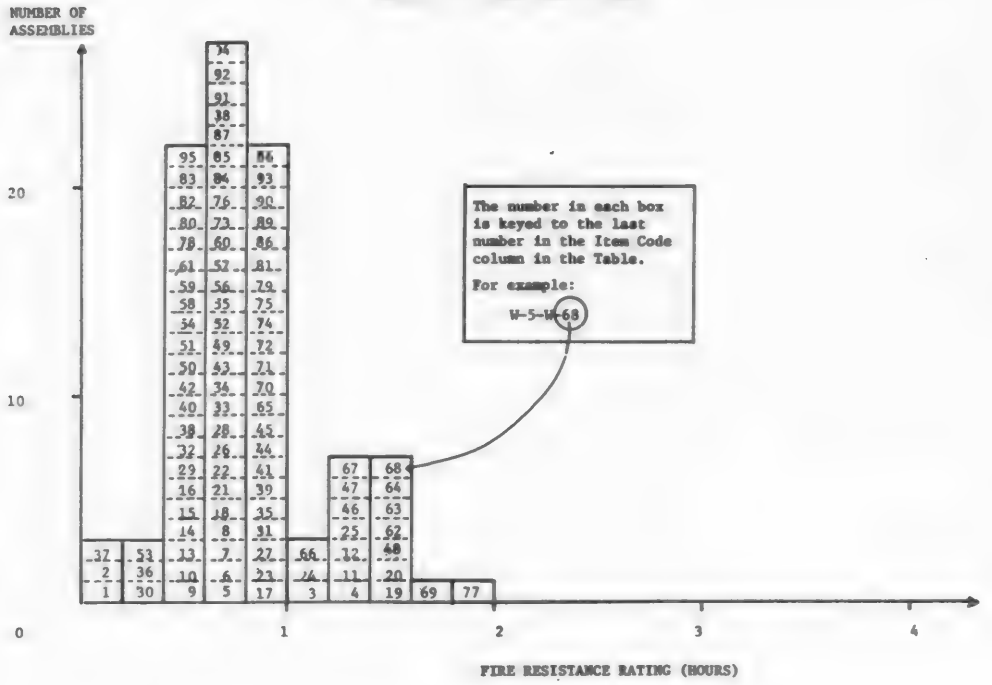


TABLE 1.3.2

WOOD FRAME WALLS

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-4-W-1	4"	2" x 4" Stud Wall; 3/16" CAB; No insulation Design A.	35min.	10min.			4	1-10	1/6
W-4-W-2	4-1/8"	2" x 4" Stud Wall; 3/16" CAB; No insulation Design A.	38min.	9 min.			4	1-10	1/6
W-4-W-3	4-3/4"	2" x 4" Stud Wall; 3/16" CAB face; 3/8" Gypsum board face; Design B.	62min.	64min.			4	1-10	1
W-5-W-4	5"	2" x 4" Stud Wall; 3/16" CAB face; ½" Gypsum board face; Design B.	79min.	—			4	1-10	1
W-4-W-5	4-3/4"	2" x 4" Stud Wall; 3/16" CAB face; 3/8" Gypsum board face; Design B.	45min.	45min.			4	1-12	3/4
W-5-W-6	5"	2" x 4" Stud Wall; 3/16" CAB face; ½" Gypsum face; Design B.	45min.	45min.			4	1-10 12-13	3/4
W-4-W-7	4"	2" x 4" Stud Wall; 3/16" CAB face; 3½"Mineral Wool Insulation; Design C.	40min.	42min.			4	1-10	2/3
W-4-W-8	4"	2" x 4" Stud Wall; 3/16" CAB face; 3½"Mineral Wool Insulation; Design C.	46min.	46min.			4	1-10	2/3
W-4-W-9	4"	2" x 4" Stud Wall; 3/16"CAB face; 3½" Mineral Wool Insulation; Design C.	30min.	30min.			4	1-10 14	½

1.3.2 (cont'd)

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-4-W-10	4-1/8"	2" x 4" Stud Wall; 3/16" CAB face; 3½" Mineral Wool Insulation; Design C.	—	30min.			4	1-8 12,14	½
W-4-W-11	4-3/4"	2" x 4" Stud Wall; 3/16" CAB face; 3/8" Gypsum Strips over Studs; 5½" Mineral Wool Insulation Design D.	79min.	79min.			4	1-10	1
W-4-W-12	4-3/4"	2" x 4" Stud Wall; 3/16" CAB face; 3/8" Gypsum Strips @ Stud Edges; 7½" Mineral Wool Insul.; Design D.	82min.	82min.			4	1-10	1
W-4-W-13	4-3/4"	2" x 4" Stud Wall; 3/16" CAB face; 3/8" Gypsum board stripe over studs; 5½" Mineral Wool Ins. Design D.	30min.	30min.			4	1-12	½
W-4-W-14	4-3/4"	2" x 4" Stud Wall; 3/16" CAB face; 3/8" Gypsum board stripe over studs; 7" Mineral Wool Ins.; Design D.	30min.	30min.			4	1-12	½
W-5-W-15	5½"	2" x 4" Stud Wall; Exposed face - CAB Shingles over 1" x 6"; Unexposed face - 1/8" CAB Sheet; 7/16" fiberboard (Wood); Design E.	34min.	—			4	1-10	½
W-5-W-16	5½"	2" x 4" Stud Wall; Exposed face - 1/8" CAB Sheet; 7/16 Fiberboard; Unexposed face - CAB Shingles over 1" x 6"; Design E.	32min.	33min.			4	1-10	½
W-5-W-17	5½"	2" x 4" Stud Wall; Exposed face - CAB Shingles over 1" x 6"; Unexposed face - 1/8" CAB Sheet; Gypsum @ stud edges; 3½" Mineral Wool Ins.; Design F.	51min.	—			4	1-10	3/4
W-5-W-18	5½"	2" x 4" Stud Wall; Exposed face - 1/8" CAB Sheet; Gypsum board @ Stud Edges; Unexposed face - CAB Shingles over 1" x 6"; 3½" Mineral Wool Insulation; Design F.	42min	—			4	1-10	2/3
W-5-W-19	5-5/8"	2" x 4" Stud Wall; Exposed face - CAB Shingles over 1" x 6"; Unexposed face - 1/8" CAB Sheet, Gypsum board @ Stud edges; 5½" Mineral Wool Insulation; Design G.	74min	85min			4	1-10	1
W-5-W-20	5-5/8"	2" x 4" Stud Wall; Unexposed face - CAB Shingles over 1"x6"; Exposed face - 1/8" CAB Sheet, Gypsum board @ 3/16" Stud edges; 7/16" Fiberboard; 5½" Mineral Wool Insul.; Design G.	79min	85min			4	1-10	1½
W-5-W-21	5-5/8"	2" x 4" Stud Wall; Exposed face - CAB Shingles 1"x 6" sheathing; Unexposed face - CAB Sheet, Gypsum board @ Stud edges; 5½" Mineral Wool Insulation; Design G.	38min	38min			4	1-10 12,14	½
W-5-W-22	5-5/8"	2" x 4" Stud Wall; Exposed face- CAB Sheet, Gypsum board @ Stud edges; Unexposed face - CAB Shingles 1"x 6" sheathing; 5½" Mineral Wood Insulation; Design G.	38min	38min			4	1-12	½
W-6-W-23	6"	2" x 4" Stud Wall; 16" O.C.; ½" Gypsum board each side; ½" gypsum plaster each side.	N/A	60min.			7	15	1
W-6-W-24	6"	2" x 4" Stud Wall; 16" O.C.; ½" Gypsum board each side; ½" Gypsum plaster each side.	N/A	68min.			7	16	1
W-6-W-25	6-7/8"	2" x 4" Stud Wall; 18" O.C.; 3/4" Gypsum plank each side; 3/16" Gypsum plaster each side.	N/A	80min.			7	15	1-1/3
W-5-W-26	5-1/8"	2" x 4" Stud Wall; 16" O.C.; 3/8" Gypsum board each side; 3/16" Gypsum plaster each side.	N/A	37min.			7	15	½
W-5-W-27	5-3/4"	2" x 4" Stud Wall; 16" O.C.; 3/8" Gypsum lath each side; ½" Gypsum plaster each side.	N/A	52min.			7	15	3/4
W-5-W-28	5"	2" x 4" Stud Wall; 16" O.C.; ½" Gypsum board each side.	N/A	37min.			7	16	½
W-5-W-29	5"	2" x 4" Stud Wall; 1/2" Fiberboard both sides 14% M.C. with F.R. Paint @ 35 gm/ft^2.	N/A	28min.			7	15	1/3
W-4-W-30	4-3/4"	2" x 4" Stud Wall; Fire Side - ½"(Wood) Fiberboard; Back face - ½" CAB; 16" O.C.	N/A	17min.			7	15,16	¼

1.3.2 (cont'd)

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-5-W-31	5-1/8"	2" x 4" Stud Wall; 16" O.C.; ½" Fiberboard Insulation with 1/32" Asbestos (both sides of each board).	N/A	50min.			7	16	3/4
W-4-W-32	4½"	2"x4" Stud Wall; 3/8" thick gypsum wallboard on both faces; insulated cavities.	note 23	25min.		1		17,18, 23	1/3
W-4-W-33	4½"	2"x 4" Stud Wall; ½" thick gypsum wallboard on both faces.	note 17	40min.		1		17,23	2/3
W-4-W-34	4½"	2"x 4" Stud Wall; ½" thick gypsum wallboard on both faces; insulated cavities.	note 17	45min.		1		17,18, 23	3/4
W-4-W-35	4½"	2"x 4" Stud Wall; ½" thick gypsum wallboard on both faces; insulated cavities.	N/A	1 hr.		1		17,18 24	1
W-4-W-36	4½"	2"x 4" Stud Wall; ½" thick, 1.1lb/ft^2 wood fiberboard sheathing on both faces.	note 23	15min.		1		17,23	1/4
W-4-W-37	4½"	2"x 4" Stud Wall; ½" thick, 0.7lb/ft^2 wood fiberboard sheathing on both faces.	note 23	10min.		1		17,23	1/6
W-4-W-38	4½"	2"x 4" Stud Wall; ½", "flameproofed", 1.6lb/ft^2 wood fiberboard sheathing on both faces.	note 23	30min.		1		17,23	½
W-4-W-39	4½"	2"x 4" Stud Wall; ½" thick gypsum wallboard on both faces; insulated cavities.	note 23	1 hr.		1		17,18 23	1
W-4-W-40	4½"	2"x 4" Stud Wall; ½" thick, 1:2, 1:3 gypsum plaster on wood lath on both faces.	note 23	30min.		1		17,21, 23	½
W-4-W-41	4½"	2"x 4" Stud Wall; ½" thick, 1:2, 1:3 gypsum plaster on wood lath on both faces; insulated cavities.	note 23	1 hr.		1		17,18, 21,23	1
W-4-W-42	4½"	2"x 4" Stud Wall; ½" thick, 1:5, 1:7.5 lime plaster on wood lath on both wall faces.	note 23	30min.		1		17,21, 23	½
W-4-W-43	4½"	2"x 4" Stud Wall; ½" thick 1:5, 1:7.5 lime plaster on wood lath on both faces, insulated cavities.	note 23	45 min.		1		17,18, 21,23	3/4
W-4-W-44	4-5/8"	2" x 4" stud wall; 3/16" thick cement-asbestos over 3/8" thick gypsum board on both faces.	note 23	1 hr.		1		25,26, 23,27	1
W-4-W-45	4-5/8"	2"x 4" Stud Wall; studs faced with 4" wide strips of 3/8" thick gypsum board; 3/16" thick cement-asbestos board on both faces; insulated cavities.	note 23	1 hr.		1		23,25, 28,27	1
W-4-W-46	4-5/8"	Same as W-4-W-45 but non-load bearing.	N/A	1½ hr.		1		24,28	1½
W-4-W-47	4-7/8"	2" x 4" Stud wall; 3/16 thick cement asbestos board over ½" thick gypsum sheathing on both faces.	note 23	1½ hr.		1		23,25, 27,26	1½
W-4-W-48	4-7/8"	Same as W-4-W-47 but non-load bearing.	N/A	1½ hr.		1		24,27	1½
W-5-W-49	5"	2"x 4" Stud Wall; exterior face: 3/4" wood sheathing, asbestos felt 14 lb/100 ft^2 and 5/32" cement-asbestos shingles. Interior face: 4" wide strips of 3/8" gypsum board over studs; wall faced with 3/16" thick cement asbestos board.	note 23	40min.		1		18,23, 25,26, 29	2/3
W-5-W-50	5"	2"x 4" Stud Wall; exterior face as per W-5-W-49; Interior face: 9/16" composite board consisting of 7/16" thick wood fiber board faced with 1/8" thick cement asbestos board; Exterior side exposed to fire.	note 23	30 min.		1		23,25 26, 30	½
W-5-W-51	5"	Same as W-5-W-50 but interior side exposed to fire.	note 23	30min.		1		23,25 26	½
W-5-W-52	5"	Same as W-5-W-49 but exterior side exposed to fire.	note 23	45min.		1		18,23 25,26	3/4
W-5-W-53	5"	2"x 4" Stud Wall; 3/4" thick T&G wood boards on both sides.	note 23	20min.		1		17,23	1/3

1.3.2 (cont'd)

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-5-W-54	5"	Same as W-5-W-53 but with insulated cavities.	note 23	35min.		1		17,18 23	½
W-5-W-55	5"	2"x 4" Stud Wall; 3/4" thick T&G wood boards on both sides with 30 lb/100 ft^2 asbestos, paper between studs and boards.	note 23	45min.		1		17,23	3/4
W-5-W-56	5"	2"x 4" Stud Wall; ½" thick, 1:2, 1:3 gypsum plaster on metal lath on both sides of wall.	note 23	45min.		1		17,21 23	3/4
W-5-W-57	5"	2"x 4" Stud Wall; 3/4" thick 2:1:8, 2:1:12 lime and Keene's cement plaster on metal lath, both sides of wall.	note 23	45min.		1		17,21 23	3/4
W-5-W-58	5"	2"x 4" Stud Wall; 3/4" thick 2:1:8, 2:1:10 lime portland cement plaster over metal lath on both sides of wall.	note 23	30min.		1		17,21 23	½
W-5-W-59	5"	2"x 4" Stud Wall, 3/4" Thick 1:5, 1:7,5 lime plaster on metal lath on both sides of wall.	note 23	30min.		1		17,21, 23	½
W-5-W-60	5"	2"x 4" Stud Wall, 3/4" thick, 1:1/30:2, 1:1/30:3 portland cement, asbestos fiber plaster on metal lath on both sides of wall.	note 23	45min.		1		17,21, 23	3/4
W-5-W-61	5"	2"x 4" Stud Wall, 3/4" thick 1:2, 1:3 portland cement plaster on metal lath on both sides of wall.	note 23	30min.		1		17,21, 23	½
W-5-W-62	5"	2"x 4" Stud Wall, 3/4" thick neat plaster on metal lath on both sides of wall.	N/A	1 hr. 30min.		1		17,22, 24	1½
W-5-W-63	5"	2"x 4" Stud Wall, 3/4" thick neat gypsum plaster on metal lath on both sides of wall.	note 23	1 hr. 30min.		1		17,21, 23	1½
W-5-W-64	5"	2"x 4" Stud Wall, 3/4" thick 1:2, 1:2 gypsum plaster on metal lath on both sides of wall, insulated cavities.	note 23	1 hr. 30min.		1		17,18, 21,23	1½
W-5-W-65	5"	2"x 4" Stud Wall, same as W-5-W-64 but wall cavities not insulated.	note 23	1 hr.		1		17,21 23	1
W-5-W-66	5"	2"x 4" Stud Wall, 3/4" thick 1:2, 1:3 gypsum plaster on metal lath on both sides of wall, insulated cavities.	note 23	1 hr. 15min.		1		17,18, 21,23	1¼
W-5-W-67	5-1/16"	Same as W-5-W-49 except cavity insulation of 1-3/4 lb/ft^2 mineral wool bats. Rating applies when either wall side exposed to fire.	note 23	1 hr. 15min.		1		23,26 25	1¼
W-5-W-68	5⅛"	2"x 4" stud wall, 7/8" thick 1:2, 1:3 gypsum plaster on metal lath on both sides of wall, insulated cavities.	note 23	1 hr. 30min		1		17,18 21,23	1½
W-5-W-69	5⅛"	2"x 4" Stud wall; 7/8" thick neat gypsum plaster applied on metal lath, on both sides of wall.	N/A	1 hr. 45min		1		17,22 24	1-3/4
W-5-W-70	5⅛"	2"x 4" stud wall; ½" thick neat gypsum plaster on 3/8" plain gypsum lath, both sides of wall.	note 23	1 hr.		1		17,22 23	1
W-5-W-71	5¼"	2"x 4" stud wall; ½" thick, 1:2, 1:2 gypsum plaster on 3/8" thick plain gypsum lath with 1-3/4"x 1-3/4" metal lath pads nailed 8" O.C. vertically, 16" O.C. horizontally, both sides of wall.	note 23	1 hr.		1		17,21 23	1
W-5-W-72	5⅛"	2"x 4" stud wall, ½" thick 1:2, 1:2 gypsum plaster on 3/8" perforated gypsum lath, one 3/4" diameter hole or larger per 16" sq. in. of lath surface, both sides of wall.	note 23	1 hr.		1		17,21 23	1
W-5-W-73	5⅛"	2"x 4" stud wall, ½" thick 1:2, 1:2 gypsum plaster on 3/8" gypsum lath (plain, indented or perforated) both sides of wall.	note 23	45min.		1		17,21 23	3/4

1.3.2 (cont'd)

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-S-W-74	5½"	2"x 4" Stud Wall, 7/8" thick 1:2, 1:3 gypsum plaster over metal lath on both sides of wall.	note 23	1 hr.		1		17,21 23	1
W-S-W-75	5½"	2"x 4" Stud Wall, 7/8" thick 1:1/30:2, 1:1/30:3 portland cement, asbestos plaster applied over metal lath on both sides of wall.	note 23	1 hr.		1		17,21 23	1
W-S-W-76	5½"	2"x 4" Stud Wall, 7/8" thick 1:2, 1:3 portland cement plaster over metal lath on both sides of wall.	note 23	45min.		1		17,21 23	3/4
W-S-W-77	5½"	2"x 4" Stud Wall, 1" thick neat gypsum plaster over metal lath on both sides of wall, non-load bearing.	N/A	2 hr.		1		17,22 24	2
W-S-W-78	5½"	2"x 4" Stud Wall, ½" thick, 1:2, 1:2 gypsum plaster on ½" thick, 0.7 lb/ft^2 wood fiberboard both sides of wall.	note 23	35min.		1		17,21 23	½
W-4-W-79	4-3/4"	2"x 4" wood stud wall. ½" thick 1:2, 1:2 gypsum plaster over wood lath on both sides of wall. Mineral wool insulation.	N/A	1 hr.			43	21,31, 35,38	1
W-4-W-80	4-3/4"	Same as W-4-W-79 but uninsulated.	N/A	35min.			43	21,31 35	½
W-4-W-81	4-3/4"	2"x 4" wood stud wall. ½" thick, 3:1:8, 3:1:12 lime, Keene's cement, sand plaster over wood lath both sides of wall. Mineral wool insulation.	N/A	1 hr.			43	21,31 35, 40	1
W-4-W-82	4-3/4"	2"x 4" wood stud wall. ½" thick 1:6½, 1:6½ lime Keene's cement plaster over wood lath both side of wall. Mineral wool insulation.	N/A	30min			43	21,31, 35,40	½
W-4-W-83	4-3/4"	2"x 4" wood stud wall. ½" thick, 1:5, 1:7.5 lime plaster over wood lath on both sides of wall.	N/A	30min.			43	21,31 35	½
W-S-W-84	5-1/8"	2"x 4" wood stud wall. 11/16" thick 1:5, 1:7.5 lime plaster over wood lath on both sides of wall. Mineral wool insulation.	N/A	45min.			43	21,31 35,39	½
W-S-W-85	5½"	2"x 4" wood stud wall. 3/4" thick 1:5, 1:7 lime plaster over wood lath on both sides of wall. Mineral wool insulation.	N/A	40min.			43	21,31 35,40	2/3
W-S-W-86	5½"	2"x 4" wood stud wall. ½" thick 2:1:12 lime, Keene's cement and sand scratch coat, ½" thick 2:1:18 lime, Keene's cement, sand sand brown coat over wood lath on both sides of wall. Mineral wool insulation.	N/A	1 hr.			43	21,31, 35,40	1
W-S-W-87	5½"	2"x 4" wood stud wall. ½" thick 1:2, 1:2 gypsum plaster over 3/8" thick plaster board on both sides of wall.	N/A	45min.			43	21,31	3/4
W-S-W-88	5½"	2"x 4" wood stud wall. ½" thick 1:2, 1:2 gypsum plaster over 3/8" thick gypsum lath on both sides of wall.	N/A	45min.			43	21,31	3/4
W-S-W-89	5½"	2"x 4" wood stud wall. ½" thick 1:2, 1:2 gypsum plaster over 3/8" gypsum lath, on both sides of wall.	N/A	1 hr.			43	21.31 33	1
W-S-W-90	5½"	2"x 4" wood stud wall. ½" thick neat plaster over 3/8" thick gypsum lath, on both sides of wall.	N/A	1 hr.			43	21,22, 31	1
W-S-W-91	5½"	2"x 4" wood stud wall. ½" thick 1:2, 1:2 gypsum plaster over 3/8" thick indented gypsum lath, on both sides of wall.	N/A	45min.			43	21,31	3/4
W-S-W-92	5½"	2"x 4" wood stud wall. ½" thick 1:2, 1:2 gypsum plaster over perforated gypsum lath, 3/8" thick on both wall faces.	N/A	45min.			43	21,31 34	3/4
W-S-W-93	5½"	2"x 4" wood stud wall. ½" thick 1:2, 1:2 gypsum plaster over 3/8" thick perforated gypsum lath on both sides of wall.	N/A	1 hr.			43	21,31	1

1.3.2 (cont'd)

Walls 4" to Less Than 6" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Ker Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
W-5-W-94	5⅛"	2"x 4" wood stud wall. ½" thick 1:2, 1:2 gypsum plaster over perforated gypsum lath 3/8" thick over both sides of wall.	N/A	45min.			43	21,31 34	3/4
W-5-W-95	5½"	2"x 4" wood stud wall. ½" thick 1:2, 1:2 gypsum plaster over ½" thick wood fiberboard plaster base on both sides of wall.	N/A	35min.			43	21,31, 36	½
W-5-W-96	5-3/4",	2"x 4" wood stud wall. 1/2" thick 1:2, 1:2 gypsum plaster over 7/8" thick flameproofed wood fiberboard, on both sides of wall.	N/A	1 hr.			43	21,31 37	1

TABLE 1.3.2

NOTES

1. All specimens 8' or 8'8" x 10'4" - i.e., ¼ of furnace size. See note 42 for design cross section.
2. Specimens tested in tandem (two per exposure).
3. Test per ASA No. A-2-1934 except where unloaded. Also, panels were of "half" size of furnace opening. Time value signifies a thermal failure time.
4. 2 x 4 Studs - 16" O.C.; where 10'4", blocking @ 2'4" height.
5. Facing 4' x 8' - cement asbestos board sheets - 3/16" thick.
6. Sheathing (diagonal)- 25/32" x 5½" - 1" x 6" pine.
7. Facing Shingles - 24" x 12" x 5/32" where used.
8. Asbestos felt - asphalt sat between sheathing and shingles.
9. Load - 30,500 lbs or 360 PSI/stud where load was tested.
10. Walls were tested beyond achievement of first test end point. A load bearing time in excess of performance time indicates that although thermal criteria were exceeded load bearing ability continued.
11. Wall was rated for 1 hr. combustible use in original source.
12. Hose stream specimen.
13. Rated 1¼ hour load bearing. Rated 1½ hour none-load bearing.
14. Failed hose stream.
15. Test terminated due to flame penetration.
16. Test terminated - local back face temperature rise.
17. Nominal 2 x 4 wood studs of No. 1 common or better lumber set edgewise. 2 x 4 plates at top and bottom and blocking at mid-height of wall.
18. Cavity insulation consists of rock wool bats 1.0 lb/ft^2 of filled cavity area.
19. Cavity insulation consists of glass-wool bats 0.6 lb/ft^2 of filled cavity area.
20. Cavity insulation consists of blown-in forck wool 2.0 lb/ft^2 of filled cavity area.
21. Mix proportions for plastered walls as follows: first ratio indicates scratch coat mix, weight of dry plaster: dry sand; second ratio indicates brown coat mix.
22. "Neat" plaster is taken to mean unsanded wood-fiber gypsum plaster.
23. Load = 360 psi of net stud cross-sectional area.
24. Rated as non load bearing.

1.3.2 (cont'd)

NOTES

25. Nominal 2 x 4 studs per note 17, spaced at 16" on center.

26. Horizontal joints in facing material supported by 2 x 4 blocking within wall.

27. Facings secured with 6 d casing nails. Nail holes predrilled and were 0.02" - 0.03" smaller than nail diameter.

28. Cavity insulation consists of mineral wool bats weighing 2lb/ft^2 of filled cavity area.

29. Interior wall face exposed to fire.

30. Exterior wall face exposed to fire.

31. Nominal 2 x 4 studs of yellow pine or Douglas-fir spaced 16" on center in a single row.

32. Studs as in note 31 except double row, with studs in rows staggered.

33. Six roofing nails with metal-lath pads around heads to each 16"x 48" lath.

34. Areas of holes less than 2-3/4% of area of lath.

35. Wood laths were nailed with either 3 d or 4 d nails, one nail to each bearing, and the end joining broken every 7th course.

36. ½" thick fiberboard plaster base nailed with 3 d or 4 d common wire nails spaced 4" - 6" on center.

37. 7/8" thick fiberboard plaster base nailed with 5 d common wire nails spaced 4" - 6" on center.

38. Mineral wool bats 1.05-1.25 lb/ft^2 with waterproofed-paper backing.

39. Blown-in mineral wool insulation, 2.2 lb/ft^2.

40. Mineral wool bats, 1.4 lb/ft^2 with waterproofed-paper backing.

41. Mineral wool bats, 0.9 lb/ft^2.

42. See wall design diagram, below.

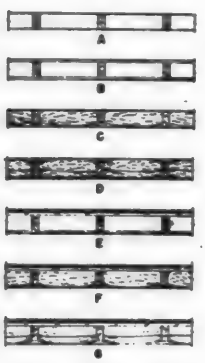


TABLE 1.3.3

WOOD FRAMED WALLS

6" to Less Than 8" Thick

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-6-W-1	6¼"	2 x 4 stud wall, ½" thick, 1:2, 1:2 gypsum plaster on 7/8" "Flame-proofed" wood fiberboard weighing 2.8 lb/ft^2 - both sides of wall.	note 3	1 hr		1		1-3	1
W-6-W-2	6⅜"	2 x 4 stud wall, ½" thick, 1:3, 1:3 gypsum plaster on 1" thick magnesium oxysulfate wood fiberboard - both sides of wall.	note 3	45min		1		1-3	3/4
W-7-W-3	7⅛"	Double row of 2 x 4 studs, ½" thick 1:2, 1:2 gypsum plaster applied over 3/8" thick perforated gypsum lath on both sides of wall. Mineral wool insulation.	n/a	1 hr			43	2,4,5	1
W-7-W-4	7⅓"	Double row of 2 x 4 studs, 5/8" thick 1:2, 1:2 gypsum plaster applied over 3/8" thick perforated gypsum lath over laid with 2" x 2", 16 gage wire fabric, on both sides of wall.	n/a	1 hr 15min			43	2,4	1¼

TABLE 1.3.3

NOTES

1. Nominal 2 x 4 wood studs of No. 1 common or better lumber set edgewise. 2 x 4 plates at top and bottom and blocking at mid-height of wall.

2. Mix proportions for plastered walls as follows: first ratio indicates scratch coat mix, weight of dry plaster: dry sand; second ration indicates brown coat mix.

3. Load = 360 psi of net stud cross-sectional area.

4. Nominal 2 x 4 studs of yellow pine of Douglas-fir spaced 16" in a double row, with studs in rows staggered.

5. Mineral wool bats, 0.19 lb/ft^2.

TABLE 1.4.1

WALLS - MISCELLANEOUS MATERIALS

Thickness - 0" to Less Than 4"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-3-Mi-1	3-7/8"	Glass brick wall - (bricks 5-3/4"x 5-3/4"x 3-7/8") ¼" mortar bed - cement/lime/sand; mounted in brick (9") wall with mastic and ½" asbestos rope.	n/a	1 hr.			7	1,2	1
W-3-Mi-2	3"	Core: 2" magnesium oxysulfate wood-fiber blocks laid in portland cement-lime mortar; Facings on both sides; See note 3.	n/a	1 hr.		1		3	¾
W-3-Mi-3	3-7/8"	Core: 8" x 4-7/8" glass blocks 3-7/8" thick weighing 4 lbs. each. Laid in portland cement lime mortar, horizontal mortar joints reinforced with metal lath.	n/a	½ hr.		1			½

TABLE 1.4.1

NOTES

1. No failure reached at 1 hour.
2. These glass blocks are assumed to be solid based on other test data available for similar but hollow units which show significantly reduced fire endurance.
3. Minimum of ½" of 1:3 sanded gypsum plaster required to develop this rating.

TABLE 1.4.2

WALLS - MISCELLANEOUS MATERIALS

Thickness - 4" to Less Than 6"

Item Code	Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
W-4-Mi-1	4"	Core: 3" magnesium oxysulfate wood-fiber blocks laid in portland cement mortar; Facings: both sides per note 1.	n/a	2 hr.		1			2

TABLE 1.4.2

NOTES

1. ½" sanded gypsum plaster. Voids in hollow blocks to be not more than 30%.

FIGURE 1.5.1

FINISH RATING

INORGANIC MATERIALS

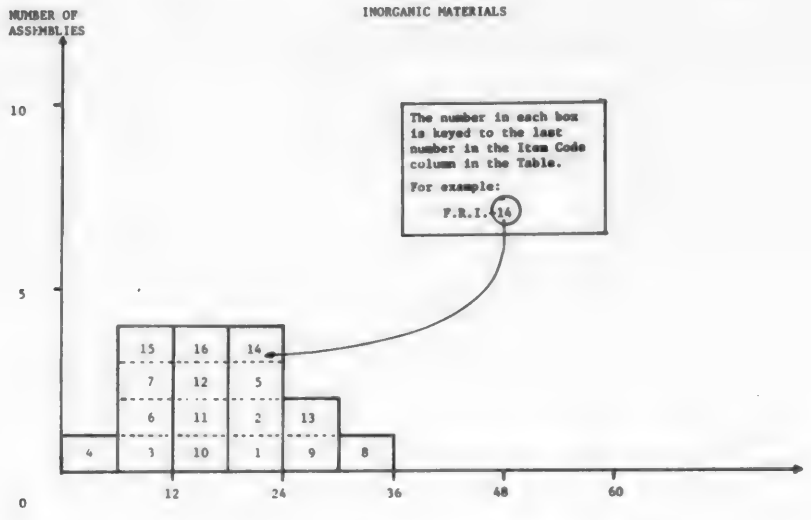


TABLE 1.5.1

FINISH RATING

INORGANIC MATERIALS

Item Code	Thickness	Construction Details	Performance: Finish Rating	Reference Number: Pre-HMS-92	Reference Number: HMS-92	Reference Number: Post-HMS-92	Notes	Rec F. R. (min.)
F.R.-I-1	9/16"	3/8" gypsum wallboard faced with 3/16" cement asbestos board.	20 minutes		1		1, 2	15
F.R.-I-2	11/16"	½" gypsum sheathing faced with 3/16" cement asbestos board.	20 minutes		1		1, 2	20
F.R.-I-3	3/16"	3/16" cement asbestos board over uninsulated cavity.	10 minutes		1		1, 2	5
F.R.-I-4	3/16"	3/16" cement asbestos board over insulated cavities.	5 minutes		1		1, 2	5
F.R.-I-5	3/4"	3/4" thick 1:2, 1:3 gypsum plaster over paper backed metal lath.	20 minutes		1		1-3	20
F.R.-I-6	3/4"	3/4" thick portland cement plaster on metal lath.	10 minutes		1		1, 2	10
F.R.-I-7	3/4"	3/4" thick, 1:5, 1:7.5 lime plaster on metal lath.	10 minutes		1		1, 2	10
F.R.-I-8	1"	1" thick neat gypsum plaster on metal lath.	35 minutes		1		1,2,4	35
F.R.-I-9	3/4"	3/4" thick neat gypsum plaster on metal lath.	30 minutes		1		1,2,4	30
F.R.-I-10	3/4"	3/4" thick 1:2, 1:2 gypsum plaster on metal lath	15 minutes		1		1-3	15
F.R.-I-11	½"	Same as F.R.-I-7, except ½" thick on wood lath	15 minutes		1		1-3	15
F.R.I-12	½"	½" thick, 1:2, 1:3 gypsum plaster on wood lath	15 minutes		1		1-3	15
F.R.I-13	7/8"	½" thick, 1:2, 1:2 gypsum plaster on 3/8" perforated gypsum lath.	30 minutes		1		1-3	30
F.R.I-14	7/8"	½" thick, 1:2, 1:2 gypsum plaster on 3/8" thick plain or indented gypsum plaster.	20 minutes		1		1-3	20
F.R.I-15	3/8"	3/8" gypsum wallboard.	10 minutes		1		1, 2	10
F.R.I-16	½"	½" gypsum wallboard.	15 minutes		1		1, 2	15

TABLE 1.5.1

NOTES

1. The finish rating is the time required to obtain an average temperature rise of 250°F, or a single point rise of 325°F, at the interface between the material being rated and the substrate being protected.

2. Tested in accordance with the Standard Specifications for Fire Tests of Building Construction and Materials, ASA No. A2-1932.

3. Mix proportions for plaster as follows: first ratio, dry weight of plaster: dry weight of sand for scratch coat; second ratio, plater: sand for brown coat.

4. Neat plaster means unsanded wood-fiber gypsum plaster.

TABLE 1.5.2

FINISH RATING

ORGANIC MATERIALS

Item Code	Thickness	Construction Details	Performance	Reference Number			Notes	Rec F.R. (min.)
			Finish Rating	Pre-HMS-92	HMS-92	Post-HMS-92		
FR-O-1	9/16"	7/16"wood fiber board faced with 1/8" cement asbestos board.	15 minutes		1		1, 2	15
FR-O-2	29/32"	3/4" wood sheathing, asbestos felt weighing 14 lb/100 ft^2 and 5/32" cement asbestos shingles.	20 minutes		1		1, 2	20
FR-O-3	1½"	1" thick magnesium oxysulfate wood fiberboard faced with 1:3, 1:3 gypsum plaster, 1/2" thick.	20 minutes.		1		1-3	20
FR-O-4	½"	½" thick wood fiberboard.	5 minutes		1		1, 2	5
FR-O-5	½"	½" thick flameproofed wood fiberboard.	10 minutes		1		1, 2	10
FR-O-6	1"	½" thick wood fiberboard faced with ½" thick 1:2, 1:2 gypsum plaster.	15 minutes		1		1-3	15
FR-O-7	1-3/8"	7/8" thick flameproofed wood fiberboard faced with ½" thick 1:2, 1:2 gypsum plaster.	30 minutes		1		1-3	30
FR-O-8	1-1/4"	1-1/4" thick plywood	30 minutes			35		30

TABLE 1.5.2

NOTES

1. The finish rating is the time required to obtain an average temperature rise of 250°F, or a single point rise of 325°F, at the interface between the material being rated and the substrate being protected.

2. Tested in accordance with the Standard Specifications for Fire Tests of Building Construction and Materials, ASA No. A2-1932.

3. Plaster ratios as follows: first ratio is for scratch coat, weight of dry plaster: weight of dry sand; second ratio is for the brown coat.

SECTION II

COLUMNS

TABLE 2.1.1

REINFORCED CONCRETE COLUMNS

Minimum Dimension - 0" to Less Than 6"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-6-RC-1	6"	6" x 6" Square Column; Gravel Aggregate Concrete (4030 PSI); Reinforcement - Vertical 4-7/8" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover 1".	34.7 tons	67min			7	1,2	1
C-6-RC-2	6"	6" x 6" Square Column; Gravel Aggregate Concrete (4200 PSI); Reinforcement - Vertical 4-½" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover - 1".	21 tons	69min			7	1,2	1

TABLE 2.1.1

NOTES

1. Collapse
2. British Test.

FIGURE 2.1.2

REINFORCED CONCRETE COLUMNS

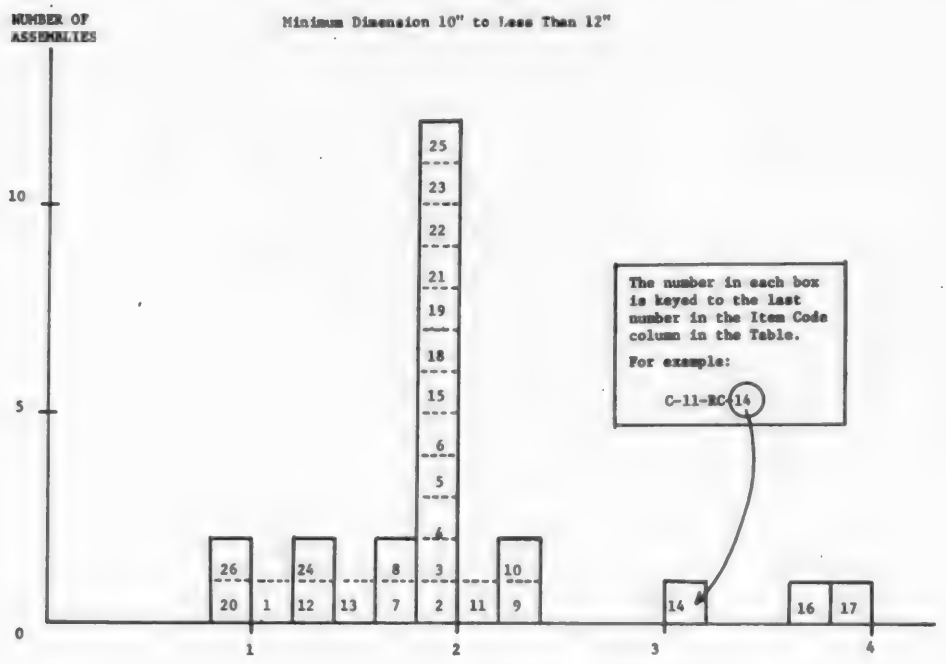


TABLE 2.1.2

REINFORCED CONCRETE COLUMNS

Columns with Minimum Dimension 10" to Less Than 12"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-10-RC-1	10"	10" Square Column; Aggregate concrete (4260 PSI); Reinforcement - Vertical 4- 1¼" rebars; Horizontal - 3/8" Ties @ 6" pitch; Cover 1½".	92.2 tons	1 hr. 2min.			7	1	1
C-10-RC-2	10"	10" Square Column; Aggregate concrete (2325 PSI); Reinforcement - Vertical 4- ½" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover 1".	46.7 tons	1 hr. 52min			7	1	1-3/4
C-10-RC-3	10"	10" Square Column; Aggregate concrete (5370 PSI); Reinforcement - Vertical 4- ½" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover 1".	46.5 tons	2hr.			7	2,3 11	2
C-10-RC-4	10"	10" Square Column;Aggregate concrete (5206 PSI); Reinforcement - Vertical 4- ½" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover 1".	46.5 tons	2 hr.			7	2,7	2
C-10-RC-5	10"	10" Square Column;Aggregate concrete (5674 PSI); Reinforcement - Vertical 4- ½" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover 1".	46.7 tons	2 hr.			7	1	2
C-10-RC-6	10"	10" Square Column;Aggregate concrete (5150 PSI); Reinforcement - Vertical 4- 1½" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover 1".	66 tons	1 hr. 43 min			7	1	1-3/4
C-10-RC-7	10"	10" Square Column;Aggregate concrete (5580 PSI); Reinforcement - Vertical 4- ½" rebars;	62.5 tons	1 hr. 38min			7	1	1½

2.1.2 (cont'd)

Columns with Minimum Dimension 10" to Less Than 12"

Item Code	Minimum Dimension	Construction Details	Performance / Reference Number					Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-10-RC-7		Continued - Horizontal - 5/16" Ties @ 6" pitch; 1" Cover.							
C-10-RC-8	10"	10" Square Column; Aggregate concrete(4080 PSI) Reinforcement - Vertical 4- 1-1/8" rebars; Horizontal - 5/16" Ties @ 6" pitch; 1-1/8" Cover	72.8 tons	1 hr. 48min.			7	1	1-3/4
C-10-RC-9	10"	10" Square Column; Aggregate concrete(2510 PSI) Reinforcement - Vertical 4- ½" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover 1".	51 tons	2 hr. 1fmin			7	1	2½
C-10-RC-10	10"	10" Square Column; Aggregate concrete(2170 PSI) Reinforcement - Vertical 4- ½" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover 1".	45 tons	2 hr. 14min			7	12	2½
C-10-RC-11	10"	10" Square Column; Gravel aggregate concrete (4015 PSI); Reinforcement - Vertical 4- ½" rebars; Horizontal - 5/16" Ties @ 6" pitch; Cover 1".	46.5 tons	2 hr. 6 min			7	I	2
C-11-RC-12	11"	11" Square Column; Gravel aggregate concrete (4150 PSI); Reinforcement: Vertical 4- 1¼" rebars; Horizontal 3/8" Ties @ 7½" pitch; Cover 1½".	61 tons	1 hr. 21min			7	I	1½
C-11-RC-13	11"	11" Square Column; Gravel aggregate concrete (4380 PSI); Reinforcement: Vertical 4- 1¼" rebars; Horizontal 3/8" Ties @ 7½" pitch; Cover 1½".	61 tons	1 hr. 26min			7	1	1½
C-11-RC-14	11"	11" Square Column; Gravel aggregate concrete (4140 PSI); Reinforcement: Vertical 4- 1¼" rebars; Horizontal 3/8"Ties @ 7½" pitch; Steel mesh around reinforcement; Cover 1½".	61 tons	3 hr. 9 min.			7	1	3
C-11-RC-15	11"	11" Square Column; Slag aggregate concrete (3690 PSI); Reinforcement: Vertical 4- 1¼" rebar; Horizontal 3/8" Ties @ 7½" pitch; Cover 1½".	91	2 hr.			7	2-5	2
C-11-RC-16	11"	11" Square Column; Limestone aggregate concrete (5230 PSI); Reinforcement: Vertical 4- 1¼" rebars; Horizontal 3/8" Ties @ 7½" pitch; Cover 1½".	91.5 tons	3 hr. 41min			7	1	3½
C-11-RC-17	11"	11" Square Column; Limestone aggregate concrete (5530 PSI); Reinforcement: Vertical 4- 1¼" rebars; Horizontal 3/8" Ties @ 7½" pitch; Cover 1½".	91.5 tons	3 hr. 47min			7	1	3½
C-11-RC-18	11"	11" Square Column; Limestone aggregate concrete (5280 PSI); Reinforcement: Vertical 4- 1¼" rebars; Horizontal 3/8" Ties @ 7½" pitch; Cover 1½".	91.5 tons	2 hr.			7	2-4,6	2
C-11-RC-19	11"	11" Square Column; Limestone aggregate concrete (4180 PSI); Reinforcement: Vertical 4- 5/8" rebars; Horizontal 3/8" Ties @ 7" pitch; Cover 1½".	71.4 tons	2 hr.			7	2,7	2

2.1.2 (cont'd)

Columns with Minimum Dimension 10" to Less Than 12"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
C-11-RC-20	11"	11" Square Column; Gravel Concrete (4530 PSI) Reinforcement: Vertical 4- 5/8" rebars; Horizontal 3/8" Ties @ 7" pitch; Cover 1½" with ½" plaster.	58.8	2 hrs.			7	2,3,9,	1½
C-11-RC-21	11"	11" Square Column; Gravel concrete (3520 PSI) Reinforcement: Vertical 4- 5/8" rebars; Horizontal 3/8" Ties @ 7" pitch; Cover 1½".	vari-able	1 hr. 24min.			7	1,8	2
C-11-RC-22	11"	11" Square Column; Aggregate concrete (3710 PSI); Reinforcement: Vertical 4- 5/8" rebars; Horizontal 3/8" Ties @ 7" pitch; Cover 1½".	58.8 tons	2 hr.			7	2,3 10	2
C-11-RC-23	11"	11" Square Column; Aggregate concrete (3790 PSI); Reinforcement: Vertical 4- 5/8" rebars; Horizontal 3/8" Ties @ 7" pitch; Cover 1½".	58.8 tons	2 hr.			7	2,3 10	2
C-11-RC-24	11"	11" Square Column; Aggregate concrete (4860 PSI); Reinforcement: Vertical 4- 5/8" rebars; Horizontal 3/8" ties @ 7" pitch; Cover 1½".	86.1 tons	1 hr. 20min.			7	1	1-1/3
C-11-RC-25	11"	11" Square Column; Aggregate concrete (4850 PSI); Reinforcement: Vertical 4- 5/8" rebars; Horizontal 3/8" ties @ 7" pitch; Cover 1½".	58.8 tons	1 hr. 59min.			7	1	1-3/4
C-11-RC-26	11"	11" Square Column; Aggregate concrete (3834 PSI); Reinforcement: Vertical 4- 5/8" rebars; Horizontal 5/16" ties @ 4½" pitch; Cover 1½".	71.4 tons	53min.			7	1	3/4

TABLE 2.1.2

NOTES

1. Failure mode - collapse.
2. Passed two hour fire exposure.
3. Passed hose stream test.
4. Reloaded effectively after 48 hours but collapsed at load in excess of original test load.
5. Failing load was 150 tons.
6. Failing load was 112 tons.
7. Failed during hose stream test.
8. Range of load 58.8 tons (initial) to 92 tons (92 min.) to 60 tons (80 min.).
9. Collapsed at 44 tons in reload after 96 hours.
10. Withstood reload after 72 hours.
11. Collapsed on reload after 48 hours.

TABLE 2.1.3

REINFORCED CONCRETE COLUMNS

Minimum Dimension 12" to Less Than 14"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-12-RC-1	12"	12" Square Column;Gravel Aggregate Concrete (2647 PSI); Reinforcement: Vertical 4- 5/8" rebars; Horizontal 5/16" ties @ 4½ pitch; Cover 2".	78.2 kmns	38min.		1	7	1	½
C-12-RC-2	12"	Reinforced Columnswith 1½" concrete outside of reinforced steel; gross diameter or side of column: 12";Group I, Column A.	--	6 hrs.		1		2,3	6
C-12-RC-3	12"	Description as per C-12-RC-2; Group I, Column B.	--	4 hrs.		1		2,3	4
C-12-RC-4	12"	Description as per C-12-RC-2; Group II, Column A.	--	4 hrs.		1		2,3	4
C-12-RC-5	12"	Description as per C-12-RC-2; Group II, Column B.	--	2 hrs. 30 min		1		2,3	2½
C-12-RC-6	12"	Description as per C-12-RC-2; Group III, Column A.	--	3 hrs.		1		2,3	3
C-12-RC-7	12"	Description as per C-12-RC-2; Group III, Column B	--	2 hrs.		1		2,3	2
C-12-RC-8	12"	Description as per C-12-RC-2; Group IV, Column A.	--	2 hrs		1		2,3	2
C-12-RC-9	12"	Description as per C-12-RC-2; Group IV, Column B.	--	1 hr. 30min.		1		2,3	1½

TABLE 2.1.3

NOTES

1. Failure mode - unspecified structural.

2. Group I - includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-includes concrete having cinder, sandstone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.

3. Groupings of aggregates and ties are the same as for structural steel columns protected solidly with concrete, the ties to be placed over the vertical reinforcing bars and the mesh, where required, to be placed within 1 in. from the surface of the column.

   Column A - working loads are assumed as carried by the area of the column inside of the lines circumscribing the reinforcing steel.

   Column B - working loads are assumed as carried by the gross area of the column.

TABLE 2.1.4

REINFORCED CONCRETE COLUMNS

Minimum Dimension 14" to Less Than 16"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-14-RC-1	14"	14" Square Columns; Gravel aggregate concrete (4295 PSI); Reinforcement: Vertical 4- 3/4" rebars; Horizontal ¼" ties @ 9" pitch; Cover 1½".	86 TONS	1 hr. 22 min			7	1	1⅛"
C-14-RC-2	14"	Reinforced Concrete column with 1½" concrete outside reinforcing steel; gross diameter or side of column 14"; Group I; Column A.	--	7 hrs.		1		2,3	7
C-14-RC-3	14"	Description as per item C-14-RC-2; Group II, Column B.	--	5 hrs.		1		2,3	5
C-14-RC-4	14"	Description as per item C-14-RC-2; Group III; Column A.	--	5 hrs.		1		2,3	5
C-14-RC-5	14"	Description as per item C-14-RC-2; Group IV; Column B.	--	3 hrs. 30min.		1		2,3	3½
C-14-RC-6	14"	Description as per item C-14-RC-2; Group III, Column A.	--	4 hrs.		1		2,3	4
C-14-RC-7	14"	Description as per item C-14-RC-2; Group III, Column B.	--	2 hrs. 30min.		1		2,3	2½
C-14-RC-8	14"	Description as per item C-14-RC-2; Group IV, Column A.	--	2 hrs. 30min.		1		2,3	2½
C-14-RC-9	14"	Description as per item C-14-RC-2; Group IV; Column B.	--	1 hr. 30 min.		1		2,3	1½

TABLE 2.1.4

NOTES

1. Failure mode - main rebars buckled between links at various points.

2. Group I - includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-includes concrete having cinder, sandstone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.

3. Groupings of aggregates and ties are the same as for structural steel columns protected solidly with concrete, the ties to be placed over the vertical reinforcing bars and the mesh, where required, to be placed within 1 in. from the surface of the column.

   Column A - working loads are assumed as carried by the area of the column inside of the lines circumscribing the reinforcing steel.

   Column B - working loads are assumed as carried by the gross area of the column.

FIGURE 2.1.5

REINFORCED CONCRETE COLUMN

Minimum Dimension 16" To Less Than 18"

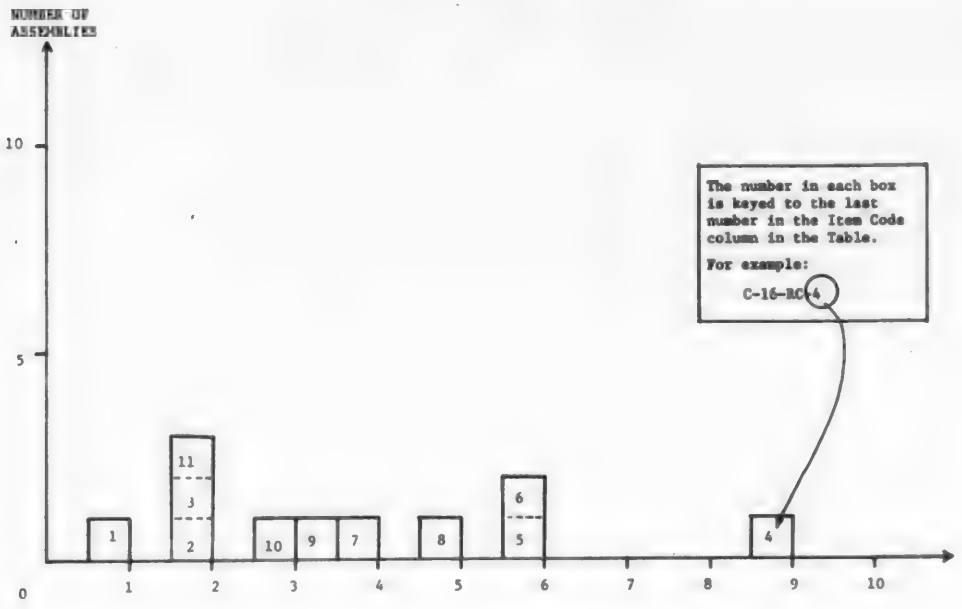


TABLE 2.1.5

REINFORCED CONCRETE COLUMNS

Minimum Dimension 16" to Less Than 18"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Man Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-16-RC-1	16"	16" Square Columns; Gravel aggregate concrete (4550 PSI); Reinforcement: Vertical 8- 1-3/8" rebars; Horizontal 5/16" ties @ 6" pitch 1-3/8" below column surface and 5/16" ties at 6" pitch linking center rebars of each face forming a smaller square in column cross section.	237 tons	1 hr.			7	1-3	1
C-16-RC-2	16"	16" Square Columns; Gravel aggregate concrete (3360 PSI); Reinforcement: Vertical 8- 1-3/8" rebars; Horizontal 5/16" ties at 6" pitch; Cover 1-3/8"	210	2 hr.			7	2,4-6	2
C-16-RC-3	16"	16" Square Columns; Gravel aggregate concrete (3980 PSI); Reinforcement: Vertical 4- 7/8" rebars; Horizontal 3/8" ties @ 6" pitch; Cover 1".	123.5 tons	2 hr.			7	2,4,7	2
C-16-RC-4	16"	Reinforced concrete columns with 1½" concrete outside reinforcing steel; gross diameter or side of column: 16"; Group I, Column A.	--	9 hrs		1		8,9	9
C-16-RC-5	16"	Description as per C-16-RC-4; Group I, Column B	--	6 hrs		1		8,9	6
C-16-RC-6	16"	Description as per C-16-RC-4; Group II, Column A.	--	6 hrs		1		8,9	6

2.1.5 (cont'd)

Minimum Dimension 16" to Less Than 18"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-RMS-92	RMS-92	Post-RMS-92		
C-16-RC-7	16"	Description as per C-16-RC-4; Group II; Column B.	—	4 hrs		1		8,9	4
C-16-RC-8	16"	Description as per C-16-RC-4; Group III, Column A.	—	5 hrs.		1		8,9	5
C-16-RC-9	16"	Description as per C-16-RC-4; Group III, Column B.	—	3 hrs. 30min.		1		8,9	3½
C-16-RC-10	16"	Description as per C-16-RC-4; Group IV, Column A.	—	3 hrs.		1		8,9	3
C-16-RC-11	16"	Description as per C-16-RC-4; Group IV, Column B.	—	2 hrs.		1		8,9	2

TABLE 2.1.5

NOTES

1. Column passed 1 hour fire test.

2. Column passed hose stream test.

3. No reload specified.

4. Column passed 2 hour fire test.

5. Column reloaded successfully after 24 hours.

6. Reinforcing details same as C-16-RC-1.

7. Column passed reload after 72 hours.

8. Group I - includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-includes concrete having cinder, sandstone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.

9. Groupings of aggregates and ties are the same as for structural steel columns protected solidly with concrete, the ties to be placed over the vertical reinforcing bars and the mesh, where required, to be placed within 1 in. from the surface of the column.

   Column A - working loads are assumed as carried by the area of the column inside of the lines circumscribing the reinforcing steel.

   Column B - working loads are assumed as carried by the gross area of the column.

TABLE 2.1.6

COLUMNS - REINFORCED CONCRETE

Minimum Dimension 18" to Less Than 20"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-2	BMS-92	Post-BMS-92		
C-18-RC-1	18"	Reinforced Concrete Columns with 1½" concrete outside reinforced steel; gross diameter or side of column: 18"; Group I, Column A.	--	11 hrs		1		1,2	11
C-18-RC-2	18"	Description as per C-18-RC-1; Group I, Column B.	--	8 hrs.		1		1,2	8
C-18-RC-3	18"	Description as per C-18-RC-1; Group II, Column A.	--	7 hrs		1		1,2	7
C-18-RC-4	18"	Description as per C-18-RC-1; Group II, Column B.	--	5 hrs		1		1,2	5
C-18-RC-5	18"	Description as per C-18-RC-1; Group III, Column A.	--	6 hrs		1		1,2	6
C-18-RC-6	18"	Description as per C-18-RC-1; Group III, Column B.	--	4 hrs		1		1,2	4
C-18-RC-7	18	Description as per C-18-RC-1; Group IV, Column A.	--	3 hrs 30min		1		1,2	3½
C-18-RC-8	18"	Description as per C-18-RC-1; Group IV, Column B.	--	2 hrs 30min		1		1,2	2½

TABLE 2.1.6

NOTES

1. Group I - includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-includes concrete having cinder, sandstone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.

2. Groupings of aggregates and ties are the same as for structural steel columns protected solidly with concrete, the ties to be placed over the vertical reinforcing bars and the mesh, where required, to be placed within 1 in. from the surface of the column.

   Column A - working loads are assumed as carried by the area of the column inside of the lines circumscribing the reinforcing steel.

   Column B - working loads are assumed as carried by the gross area of the column.

FIGURE 2.1.7

REINFORCED CONCRETE COLUMN

Minimum Dimension 20" to Less Than 22"

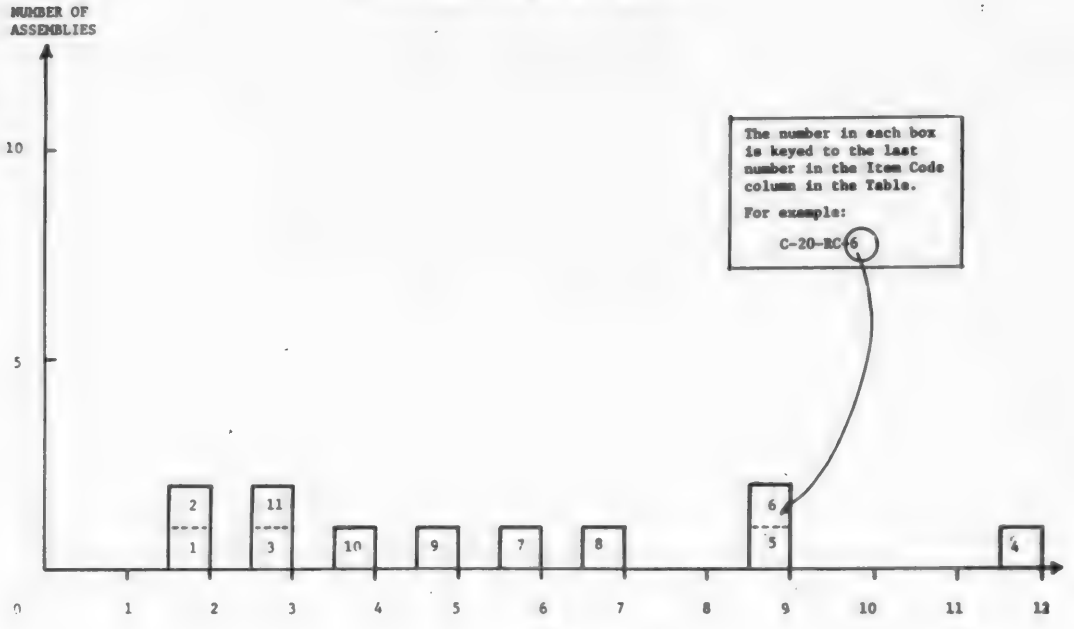


TABLE 2.1.7

REINFORCED CONCRETE COLUMNS

Minimum Dimension 20" to Less Than 22"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-20-RC-1	20"	20" Square Column; Gravel aggregate concrete (6690 PSI); Reinforcement: Vertical 4- 1-3/4" rebars; Horizontal 3/8" wire @ 6" pitch; Cover 1-3/4".	367 kmm	2 hr.			7	1-3	2
C-20-RC-2	20"	20" Square Column; Gravel aggregate concrete (4330 PSI); Reinforcement: Vertical 4- 1-3/4" rebars; Horizontal 3/8" Ties @ 6" pitch; Cover 1-3/4"	327 kmm	2 hr.			7	1,2,4	2
C-20-RC-3	20¼"	20¼" Square Column; Gravel aggregate concrete (4230 PSI); Reinforcement: Vertical 4- 1-1/8" rebar; Horizontal 3/8" wire @ 5" pitch; Cover 1-1/8".	199 kmm	2 hr. 56min.			7	5	2-3/4
C-20-RC-4	20"	Reinforced Concrete Column with 1½" concrete outside of reinforcing steel; gross diameter or side of column: 20"; Group I, Column A.	—	12 hr		I		6,7	12
C-20-RC-5	20"	Description as per C-20-RC-4; Group I, Column B.	—	9 hrs		I		6,7	9
C-20-RC-6	20"	Description as per C-20-RC-4; Group II, Column A.	—	9 hrs		I		6,7	9
C-20-RC-7	20"	Description as per C-20-RC-4; Group II, Column B.	—	6 hrs		I		6,7	6

2.1.7 (cont'd)

Minimum Dimension 20" to Less Than 22"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
C-20-RC-8	20"	Description as per C-20-RC-4; Group III, Column A.	--	7 hrs.		1		6,7	7
C-20-RC-9	20"	Description as per C-20-RC-4; Group III, Column B.	--	5 hrs.		1		6,7	5
C-20-RC-10	20"	Description as per C-20-RC-4; Group IV, Column A.	--	4 hrs.		1		6,7	4
C-20-RC-11	20"	Description as per C-20-RC-4; Group IV, Column B.	--	3 hrs.		1		6,7	3

TABLE 2.1.7

NOTES

1. Passed 2 hr. fire test.
2. Passed hose stream test.
3. Failed during reload at 300 tons.
4. Passed reload after 72 hours.
5. Failure mode - collapse.
6. Group I - includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-includes concrete having cinder, sandstone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.
7. Groupings of aggregates and ties are the same as for structural steel columns protected solidly with concrete, the ties to be placed over the vertical reinforcing bars and the mesh, where required, to be placed within 1 in. from the surface of the column.

   Column A - working loads are assumed as carried by the area of the column inside of the lines circumscribing the reinforcing steel.

   Column B - working loads are assumed as carried by the gross area of the column.

TABLE 2.1.8

HEXAGONAL REINFORCED CONCRETE COLUMNS

Diameter - 12" to Less Than 14"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-12-HRC-1	12"	12" Hexagonal Columns;Gravel aggregate concrete (4420 PSI); Vertical Reinforcement 8-⅝" rebars; Horizontal Reinforcement - helical 5/16" winding on 1½" pitch; cover 1/2".	88 tons	58 min			7	1	3/4
C-12-HRC-2	12"	12" Hexagonal Columns;Gravel aggregate concrete (3460 PSI); Vertical Reinforcement 8- ½" rebar; Horizontal Reinforcement 5/16" helical winding @ 1½" pitch; Cover ½".	78.7 tons	1 hr.			7	2	1

TABLE 2.1.8

NOTES

1. Failure Mode - collapse.
2. Test stopped at 1 hour.

TABLE 2.1.9

HEXAGONAL REINFORCED CONCRETE COLUMNS

Diameter - 14" to Less Than 16"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-14-HRC-1	14"	14" Hexagonal Columns;Gravel aggregate concrete (4970 PSI); Vertical Reinforcement 8- 1/2" rebar; Horizontal 5/16" helical winding on 2" pitch; Cover ½".	90 tons	2 hr.			7	1-3	2

TABLE 2.1.9

NOTES

1. Withstood 2 hour fire test.
2. Withstood hose stream test.
3. Withstood reload after 48 hours.

TABLE 2.1.10

HEXAGONAL REINFORCED CONCRETE COLUMNS

Diameter - 16" to Less Than 18"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-16-HRC-1	16"	16" Hexagonal Column; Gravel concrete (6320 PSI); Vertical Reinforcement 8- 5/8" rebar; Horizontal Reinforcement 5/16" helical winding on 3/4" pitch; Cover ½".	140 tons	1 hr. 55 min			7	1	1-3/4
C-16-HRC-2	16"	16" Hexagonal Column; Gravel aggregate concrete (5580 PSI); Vertical Reinforcement 8- 5/8" rebar; Horizontal Reinforcement 5/16" helical winding on 1-3/4" pitch; Cover ½".	124 tons	2 hr.			7	2	8

TABLE 2.1.10

NOTES

1. Failure Mode - Collapse
2. Failed on furnace removal.

TABLE 2.1.11

HEXAGONAL REINFORCED CONCRETE COLUMNS

Diameter - 20" to Less Than 22"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-20-HRC-1	20"	20" Hexagonal Column; Gravel Concrete (6 80 PSI); Vertical Reinforcement: 3/4" rebar; Horizontal Reinforcement: 5/16" helical winding on 1-3/4" pitch; Cover ½".	211 tons	2 hr.			7	1	2
C-20-HRC-2	20"	20" Hexagonal Column; Gravel Concrete (5080 PSI); Vertical Reinforcement: 3/4" rebar; Horizontal Reinforcement: 5/16" wire on 1-3/4" pitch; Cover ½".	184 tons	2 hr. 15min			7	2,3,4	2½

TABLE 2.1.11

NOTES

1. Column collapsed on furnace removal.
2. Passed 2½ hr. fire test.
3. Passed hose stream test.
4. Withstood reload after 48 hours.

TABLE 2.2

ROUND CAST IRON COLUMNS

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-7-CI-1	7" O.D.	Column: .6" min. thickness metal, unprotected.	--	30min.		1			1/2
C-7-CI-2	7" O.D.	Column: .6" min. metal thickness concrete filled, outside unprotected.	--	45min.		1			3/4
C-11-CI-3	11" O.D.	Column: .6" minimum metal thickness; Protection: 1½" portland cement plaster on high ribbed metal lath, ½" broken air space.	--	3 hrs.		1			3
C-11-CI-4	11" O.D.	Column: .6" min. metal thickness; Protection: 2" concrete other than siliceous aggregate.	--	2 hrs. 30 min		1			2-1/2
C-12-CI-5	12.5"O.D.	Column: 7" O.D. .6" min. metal thickness; Protection: 2" porous hollow tile, 3/4" mortar between tile and column, outside wire ties.	--	3 hrs.		1			3
C-7-CI-6	7.6" O.D.	Column: 7" I.D., 3/10" min. thickness metal, concrete filled unprotected.	--	30min.		1			1/2
C-8-CI-7	8.6" O.D.	Column: 8" I.D., 3/10" min. thickness metal, concrete filled reinforced with 4- 3½"x 3/8" angles, in fill; unprotected outside.	--	1 hr.		1			1

FIGURE 2.3

STEEL COLUMNS - GYPSUM ENCASEMENTS

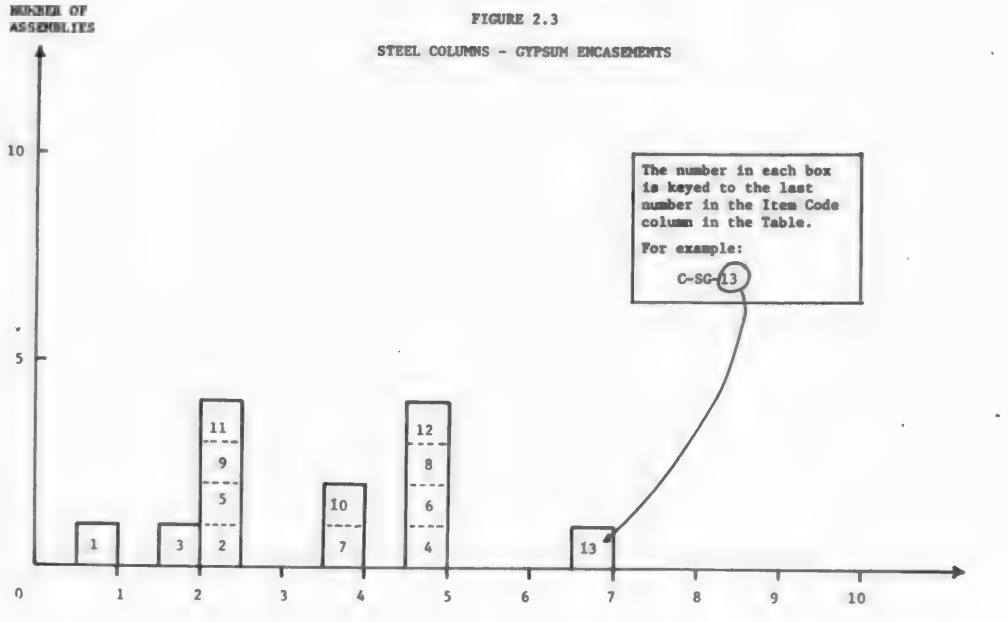


TABLE 2.3

STEEL COLUMNS - GYPSUM ENCASEMENTS

Item Code	Minimum Area of Solid Material	Construction Details	Performance		Reference Number			Notes	Recc. Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-SG-1	--	Steel protected with 3/4" 1:3 sanded gypsum or 1" 1:2½ portland cement plaster on wire or lath; one layer.	--	1 hr.		1			1
C-SG-2	--	Same as C-SG-1; two layers.	--	2 hrs 30min		1			2-1/2
C-SG-3	130 in^2	2" solid blocks with wire mesh in horizontal joints, 1" mortar on flange, reentrant space filled with block and mortar.	--	2 hrs.		1			2
C-SG-4	150 $in.^2$	Same as C-130-SG-3 with ½" sanded gypsum plaster.	--	5 hrs.		1			5
C-SG-5	130 $in.^2$	2" solid blocks with wire mesh in horizontal joints, 1" mortar on flange, reentrant space filled with gypsum concrete.	--	2 hrs. 30 min		1			2-1/2
C-SG-6	150 $in.^2$	Same as C-130-SG-5 with ½" sanded gypsum plaster.	--	5 hrs.		1			5
C-SG-7	300 $in.^2$	4" solid blocks with wire mesh in horizontal joints, 1" mortar on flange reentrant space filled with block and mortar.	--	4 hrs.		1			4
C-SG-8	300 $in.^2$	Same as C-300-SG-7 with reentrant space filled with gypsum concrete.	--	5 hrs.		1			5
C-SG-9	85 $in.^2$	2" solid blocks with cramps at horizontal joints, mortar on flange only at horizontal joints, reentrant space not filled.	--	2 hrs. 30 min		1			2-1/2
C-SG-10	105 $in.^2$	Same as C-85-SG-9 with ½" sanded gypsum plaster	--	4 hrs.		1			4
C-SG-11	95 $in.^2$	3" hollow blocks with cramps at horizontal joints, mortar on flange only at horizontal joints, reentrant space not filled.	--	2 hrs. 30 min		1			2-1/2
C-SG-12	120 $in.^2$	Same as C-95-SG-11 with ½" sanded gypsum plaster.	--	5 hrs.		1			5
C-SG-13	130 $in.^2$	2" neat fibered gypsum reentrant space filled poured solid and reinforced with 4"x 4" wire mesh ½" sanded gypsum plaster.	--	7 hrs.		1			7

TABLE 2.4

TIMBER COLUMNS

Minimum Dimension - 11"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-11-TC-1	11"	With unprotected steel plate cap	--	30min		1		1,2	½
C-11-TC-2	11"	With unprotected cast iron cap and pintle	--	45min		1		1,2	3/4
C-11-TC-3	11"	With concrete or protected steel or cast iron cap.	--	1 hr. 15min		1		1,2	1¼
C-11-TC-4	11"	With 3/8" gypsum wallboard over column and over cast iron or steel cap.	--	1 hr. 15min		1		1,2	1¼
C-11-TC-5	11"	With 1" portland cement plaster on wire lath over column and over cast iron or steel cap; 3/4" air space.	--	2 hrs		1		1,2	3

TABLE 2.4

NOTES

1. Minimum Area: 120 $in.^2$
2. Type of wood: Long leaf pine or douglas fir.

TABLE 2.5.1.1

STEEL COLUMNS - CONCRETE ENCASEMENTS

Minimum Dimension Less Than 6"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-5-SC-1	5"	5" x 6" Outer dimensions; 4" x 3" x 10 lbs. - H Beam; Protection - Gravel Concrete (4900 PSI) 6" x 4" - 13 SWG mesh.	12 tons	1 hr. 29min			7	1	1½

TABLE 2.5.1.1

NOTES

1. Failure mode - collapse.

TABLE 2.5.1.2

STEEL COLUMNS - CONCRETE ENCASEMENTS

Minimum Dimension 6" to Less Than 8"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-7-SC-1	7"	7" x 8" Column; 4" x 3" x 10" H Beam; Protection - Brick filled concrete (6220 PSI); 6"x 4" mesh - 13 S.W.G.; mesh 1" below column surface.	12 tons	2 hrs. 46 min			7	1	3
C-7-SC-2	7"	7" x 8" Column; 4" x 3" x 10 lbs. H Beam; Protection: Gravel concrete (5140 PSI) 6" x 4" 13 S.W.G. mesh 1" below surface.	12 tons	3 hrs. 1 min.			7	1	2-3/4
C-7-SC-3	7"	7" x 8" Column; 4"x 3" x 10 lbs. H Beam; Protection: Concrete (4540 PSI) 6" x 4" - 13 SWG mesh; 1" below column surface.	12 tons	3 hr. 9 min.			7	1	3
C-7-SC-4	7"	7" x 8" Column; 4"x 3"x 10 lbs. H. Beam; Protection: Gravel concrete (5520 PSI); 4"x 4" mesh; 16 SWG .	12 tons	2 hr. 50min.			7	1	2-3/4

TABLE 2.5.1.2

NOTES

1. Failure mode - collapse.

FIGURE 2.5.1.3

STEEL COLUMN - CONCRETE ENCASEMENTS

Minimum Dimension 8" to Less Than 10"

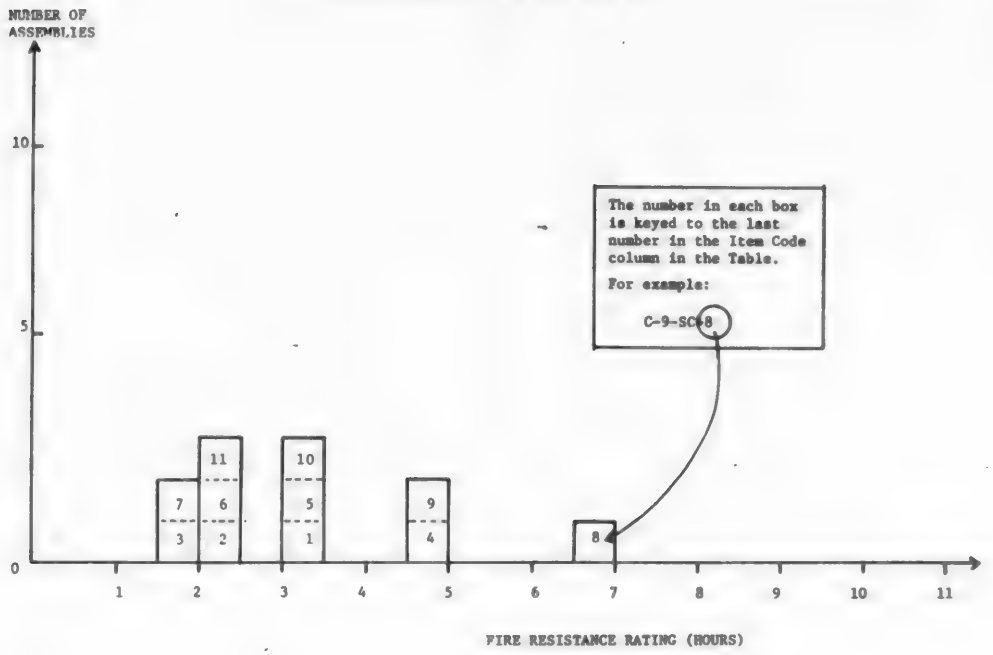


TABLE 2.5.1.3

STEEL COLUMNS - CONCRETE ENCASEMENTS

Minimum Dimension 8" to Less Than 10"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec. Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS -92		
C-8-SC-1	8½"	8½"x 10" Column; 6"x 4½" x 20 lbs. H Beam; Protection: Gravel Concrete (5140 PSI) 6" x 4" 13 SWG mesh.	39 tons	3 hr. 8 min.			7	1	3
C-8-SC-2	8"	8"x 10" Column; 8"x 6"x 35lbs I Beam; Protection: Gravel concrete (4240 PSI) 4"x 6" mesh; 13 SWG with ½" cover.	90 tons	2 hr. 1 min.			7	1	2
C-8-SC-3	8"	8"x 10" Concrete encased column; 8"x 6" x 35 lb H Beam; Protection: Aggregate concrete (3750 PSI) with 4" mesh - 16 SWG reinforcing ½" below column surface.	90 tons	1 hr. 58min.			7	1	1-3/4
C-8-SC-4	8"	6"x 6" Steel Column with 2" outside protection. Group I.	--	5 hrs		1		2	5
C-8-SC-5	8"	6"x 6" Steel Column with 2" outside protection. Group II.	--	3 hrs 30 min		1		2	3½
C-8-SC-6	8"	6"x 6" Steel Column with 2" outside protection. Group III.	--	2 hrs 30 min		1		2	2½
C-8-SC-7	8"	6"x 6" Steel Column with 2" outside protection. Group IV.	--	1 hr. 45 min		1		2	1-3/4

2.5.1.3 (cont'd)

Smallest Dimension - 8" to Less Than 10"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
C-9-SC-8	9"	6"x 6" Steel Column with 3" outside protection Group I.	--	7 hrs.		1		2	7
C-9-SC-9	9"	6"x 6" Steel Column with 3" outside protection Group II.	--	5 hrs		1		2	5
C-9-SC-10	9"	6"x 6" Steel Column with 3" outside protection Group III.	--	3 hrs 30 min		1		2	3½
C-9-SC-11	9"	6"x 6" Steel Column with 3" outside protection Group IV.	--	2 hrs. 30 min		1		2	2½

TABLE 2.5.1.3

NOTES

1. Failure mode - collapse.

2. Group I - includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-includes concrete having cinder, sandstone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.

FIGURE 2.5.1.4

STEEL COLUMNS - CONCRETE ENCASEMENTS

Minimum Dimension - 10" to Less Than 12"

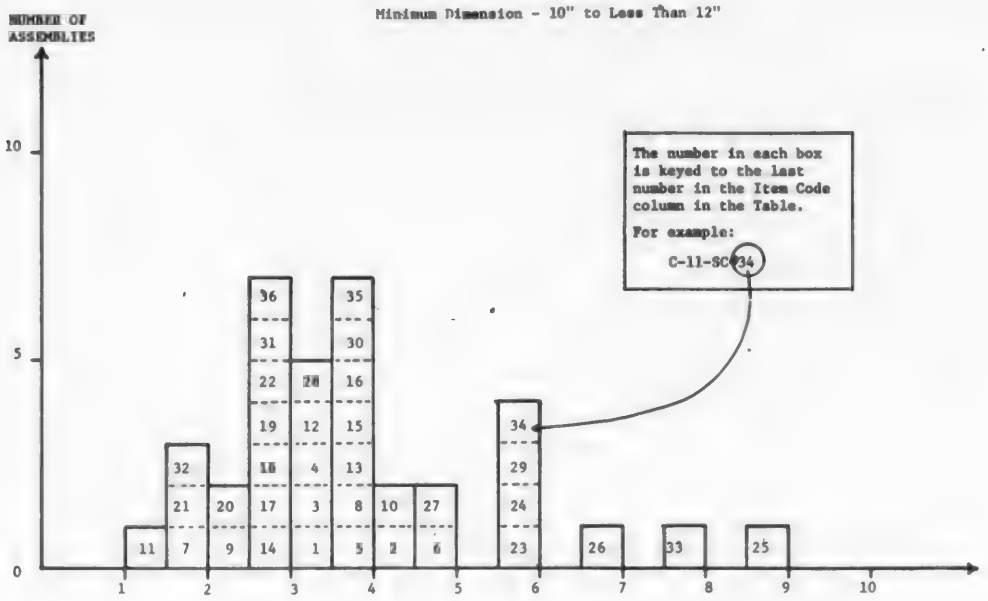


TABLE 2.5.1.4

STEEL COLUMNS - CONCRETE ENCASEMENTS

Minimum Dimension - 10" to Less Than 12"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-10-SC-1	10"	10"x 12" concrete encased steel column; 8"x 6"x 35 lb. "H" Beam; Protection: Gravel aggregate concrete (3640 PSI); Mesh 6"x 4"; 13 SWG, 1" below column surface.	90 tons	3 hr. 7 min.			7	1,2	3
C-10-SC-2	10"	Column: 10"x 16"; 8"x 6"x 35 lb. "H" beam; Protection: Clay brick concrete (3630 PSI); 6" x 4" mesh; 13 SWG, mesh 1" below column surface.	90 tons	4 hr. 6 min.			7	2	4
C-10-SC-3	10"	Column: 10"x 12"; 8"x 6"x 35 lb. "H" beam; Protection: Concrete of crushed stone and sand (3930 PSI) 6"x 4" - 13 SWG mesh; 1" below column surface.	90 tons	3 hr. 17min.			7	2	3-¼
C-10-SC-4	10"	Column: 10"x 12"; 8"x 6"x 35 lb. "H" beam; Protection: Concrete of crushed basalt and sand (4350 PSI) 6"x 4" 13 SWG mesh; 1" below column surface.	90 tons	3 hr. 22min.			7	2	3-1/3
C-10-SC-5	10"	Column: 10"x 12"; 8"x 6"x 35 lb. "H" beam; Protection: Concrete gravel aggregate (5570 PSI); 6"x 4" mesh; 13 SWG.	90 tons	3 hr. 39min.			7	2	3½
C-10-SC-6	10"	Column: 10"x 16"; 8"x 6"x 35 lb "I" beam; Protection: gravel concrete (4950 PSI); mesh 6"x 4" 13 SWG; 1" below column surface.	90 tons	4 hr. 32min.			7	2	4½
C-10-SC-7	10"	10"x 12" concrete encased steel column; 8"x6" x 35 lb. "H" beam; Protection: aggregate concrete (1370 PSI) with 6"x 4" mesh; 13 SWG reinforcing 1" below column surface.	90 tons	2 hr.			7	3,4	2

2.5.1.4 (cont'd)

Minimum Dimension - 10" to Less Than 12"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-10-SC-8	10"	10"x 12" Concrete encased steel column; 8"x 6"x 35 lb. "H" column; Protection: aggregate concrete (4000 PSI) with 13 SWG iron wire loosely wound around column @ 6" pitch about 2" beneath column surface.	86 tons	3 hr. 36min			7	2	3½
C-10-SC-9	10"	10"x 12" concrete encased steel column; 8"x 6" x 35 lb. "H" beam; Protection: aggregate concrete (3290 PSI); 2" cover minimum.	86 tons	2 hr. 8 min			7	2	2
C-10-SC-10	10"	10"x 14" concrete encased steel column; 8"x 6" x 35 lb. "H" column; Protection: crushed brick filled concrete (5310 PSI) with 6"x 4" mesh 13 SWG reinforcement 1" beneath column surface.	90 tons	4 hr. 28min			7	2	4-1/3
C-10-SC-11	10"	10"x 12" concrete encased column; 8"x 6"x 35lb "H" beam; Protection: aggregate concrete (342 PSI) with 6"x 4" mesh; 13 SWG reinforcements 1" below surface.	90 tons	1 hr. 2 min			7	2	1
C-10-SC-12	10"	10"x 12" concrete encased steel column; 8"x 6" x 35 lb. "H" beams; Protection: aggregate concrete (4480 PSI) 4- 3/8" vertical rebars @ H beam edges with 3/16" spacers @ beam surface @ 3' pitch and 3/16 binders @ 10" pitch; 2" concrete cover.	90 tons	3 hr. 2 min			7	2	3
C-10-SC-13	10"	10"x 12" Concrete encased steel column; 8"x 6" x 35 lb "H" beam; Protection: aggregate concrete (5070 PSI) with 6"x 4" mesh; 13 SWG reinforcing @ 6" beam sides wrapped and held by wire ties across (open) 8" beam face; Reinforcements wrapped in 6"x 4" mesh; 13 SWG throughout with ½" cover to column surface.	90 tons	3 hr. 59min			7	2	3-3/4
C-10-SC-14	10"	10"x 12" concrete encased steel column; 8"x 6" x 35 lb. "H" column; Protection: aggregate concrete (4410 PSI) with 6"x 4" mesh; 13 SWG reinforcement 1½" below column surface; ½" lime-cement plaster with 3/8" gypsum plaster finish.	90 tons	2 hr. 50min			7	2	2-3/4
C-10-SC-15	10"	10"x 12" concrete encased steel column; 8"x 6" x 35 lb. "H" beam; Protection: crushed clay brick filled concrete (4260 PSI) with 6"x 4" mesh; 13 SWG reinforcing 1" below column surface.	90 tons	3 hr. 54min			7	2	3-3/4
C-10-SC-16	10"	10"x 12" concrete encased steel columns; 8"x 6"x 35 lb. "H" beams; Protection: Limestone aggregate concrete (4350 PSI) 6"x 4" mesh; 13 SWG reinforcing 1" below column surface.	90 tons	3 hr. 54min			7	2	3-3/4
C-10-SC-17	10"	10"x 12" concrete encased steel column; 8"x 6" x 35 lb. "H" beam; Protection: Limestone aggregate concrete(5300 PSI) with 6"x 4"; 13 SWG wire mesh 1" below column surface.	90 tons	3 hr.			7	4,5	3
C-10-SC-18	10"	10"x 12" concrete encased steel column; 8"x 6" x 35 lb. "H" beam; Protection: Limestone aggregate concrete (4800 PSI) with 6"x 4"; 13 SWG mesh reinforcement 1" below surface.	90 tons	3 hr.			7	4,5	3
C-10-SC-19	10"	10"x 14" concrete encased steel column; 12"x 8"x 65 lb. "H" beam; Protection: aggregate concrete (3900 PSI) 4" mesh; 16 SWG reinforcing ¼" below column surface.	118 tons	2 hr. 42min			7	2	2
C-10-SC-20	10"	10"x 14" concrete encased steel column; 12"x 8"x 65 lb. "H" beam; Protection: aggregate concrete (4930 PSI); 4" mesh; 16 SWG reinforcing ¼" below column surface.	177 tons	2 hr. 8 min			7	2	2
C-10-SC-21	10-3/8"	10-3/8"x 12-3/8" concrete encased steel column 8"x 6"x 35 lb. "H" beam; Protection: aggregate concrete (835 PSI) with 6"x 4" mesh; 13 SWG reinforcing 1-3/16" below column surface; 3/16" gypsum plaster finish.	90 tons	2 hr.			7	3,4	2
C-11-SC-22	11"	11"x 13" concrete encased steel column; 8"x 6" x 35 lb. "H" beam; Protection: "open texture" brick filled concrete (890 PSI) with 6" x 4" mesh; 13 SWG reinforcing 1½" below column surface; 3/8" lime cement plaster; 1/8" gypsum plaster finish.	90 tons	3 hr.			7	6,7	3

2.5.1.4 (cont'd)

Minimum Dimension - 10" to Less Than 12"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-11-SC-23	11"	11"x 12" column; 4"x 3"x 10 lb. "H" beam; gravel concrete (4550 PSI); 6"x 4" - 13 SWG mesh reinforcing; 1" below column surface.	12 tons	6 hr.			7	7,8	6
C-11-SC-24	11"	11"x 12" column; 4"x 3"x 10 lb. "H" beam; Protection: gravel aggregate concrete (3830 PSI) with 4"x 4" mesh; 16 SWG; 1" below column surface.	16 tons	5 hr. 32min			7	2	5½
C-10-SC-25	10"	6"x 6" steel column with 4" outside protection Group I.	--	9 hrs		1		9	9
C-10-SC-26	10"	Description as per C-10-SC-25; Group II.	--	7 hrs		1		9	7
C-10-SC-27	10"	Description as per C-10-SC-25; Group III.	--	5 hrs		1		9	5
C-10-SC-28	10"	Description as per C-10-SC-25; Group IV.	--	3 hrs 30 min		1		9	3½
C-10-SC-29	10"	8"x 8" steel column with 2" outside protection Group I.	--	6 hrs		1		9	6
C-10-SC-30	10"	Description as per C-10-SC-29; Group II.	--	4 hrs		1		9	4
C-10-SC-31	10"	Description as per C-10-SC-29; Group III.	--	3 hrs		1		9	3
C-10-SC-32	10"	Description as per C-10-SC-29; Group IV.	--	2 hrs		1		9	2
C-11-SC-33	11"	8"x 8" steel column with 3" outside protection; Group I.	--	8 hrs.		1		9	8
C-11-SC-34	11"	Description as per C-11-SC-33; Group II.	--	6 hrs.		1		9	6
C-11-SC-35	11"	Description as per C-11-SC-33; Group III.	--	4 hrs.		1		9	4
C-11-SC-36	11"	Description as per C-11-SC-33; Group IV.	--	3 hrs.		1		9	3

TABLE 2.5.1.4

NOTES

1. Tested under total restraint load to prevent expansion - minimum load 90 tons.
2. Failure mode - collapse.
3. Passed 2 hour fire test ("Grade C" - British).
4. Passed hose stream test.
5. Column tested and passed 3 hour grade fire resistance (British).
6. Column passed 3 hour fire test.
7. Column collapsed during hose stream testing.
8. Column passed 6 hour fire test.
9. Group I - includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-includes concrete having cinder, sandstone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.

FIGURE 2.5.1.5

STEEL COLUMN - CONCRETE ENCASEMENTS

Minimum Dimension 12" to Less Than 14"

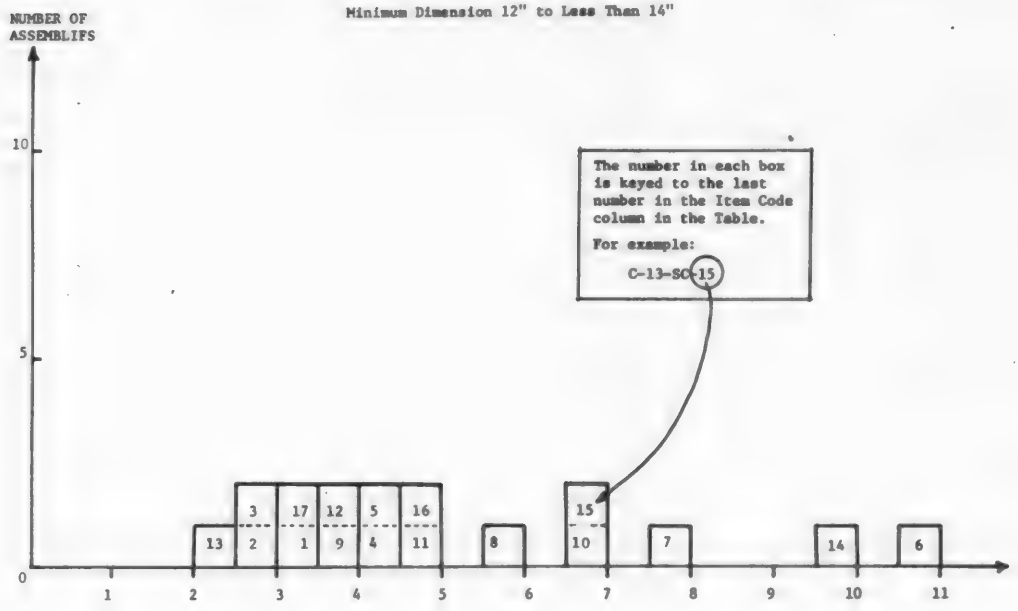


TABLE 2.5.1.5

STEEL COLUMNS - CONCRETE ENCASEMENTS

Minimum Dimension - 12" to Less Than 14"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-12-SC-1	12"	12"x 14" Concrete encased steel column; 8"x 6" x 35lb "H" beam; Protection: Aggregate concrete(4150 PSI) with 4" mesh; 16 SWG reinforcing 1" below column surface.	120 tons	3 hr. 24min			7	1	3-1/3
C-12-SC-2	12"	12"x 16" Concrete encased column; 8"x 6"x 35lb. "H" beam; Protection: Aggregate concrete (4300 PSI) with 4" mesh; 16 SWG reinforcing 1" below surface.	90 tons	2 hr. 52min			7	1	2-3/4
C-12-SC-3	12"	12"x 16" Concrete encased steel column; 12"x 8" x 65 lb "H" column; Protection: Gravel aggregate concrete (3550 PSI) with 4" mesh; 16 SWG reinforcement 1" below column surface.	177 tons	2 hr. 31min			7	1	2⅓
C-12-SC-4	12"	12"x 16" concrete encased column; 12"x 8"x 65lb "H" beam; Protection: Aggregate concrete (3450 PSI) with 4" - 16 SWG mesh reinforcement 1" below column surface.	118 tons	4 hr. 4 min			7	1	4
C-12-SC-5	12½"	12½"x 14" Column; 6" x 4½" x 20 lb. "H" beam; Protection: Gravel aggregate concrete (3750 PSI) with 4"x 4" mesh; 16 SWG reinforcing 1" below column surface.	52 tons	4 hr. 29min			7	1	4-1/3
C-12-SC-6	12"	8"x 8" steel column; 2" outside protection; Group I.	--	11 hr			1	2	11

2.5.1.5 (cont'd)

Minimum Dimension - 12" to Less Than 14"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
C-12-SC-7	12"	Description as per C-12-SC-6; Group II.	--	8 hrs.		1		1	8
C-12-SC-8	12"	Description as per C-12-SC-6; Group III.	--	6 hrs.		1		1	6
C-12-SC-9	12"	Description as per C-12-SC-6; Group IV.	--	4 hrs.		1		1	4
C-12-SC-10	12"	10"x 10" steel column with 2" outside protection; Group I.	--	7 hrs.		1		2	7
C-12-SC-11	12"	Description as per C-12-SC-10; Group II.	--	5 hrs.		1		2	5
C-12-SC-12	12"	Description as per C-12-SC-10; Group III.	--	4 hrs.		1		2	4
C-12-SC-13	12"	Description as per C-12-SC-10; Group IV.	--	2 hrs. 30 min		1		1	2½
C-13-SC-14	13"	10"x 10" steel column with 3" outside protection; Group I.	--	10 hrs		1		1	10
C-13-SC-15	13"	Description as per C-13-SC-14; Group II.	--	7 hrs.		1		2	7
C-13-SC-16	13"	Description as per C-13-SC-14; Group III.	--	5 hrs.		1		1	5
C-13-SC-17	13"	Description as per C-13-SC-14; Group IV.	--	3 hrs. 30 min		1		1	3½

TABLE 2.5.1.5

NOTES

1. Failure mode - collapse.

2. Group I - includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-includes concrete having cinder, sandstone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.

FIGURE 2.5.1.6

STEEL COLUMN - CONCRETE ENCASEMENTS

Minimum Dimension 14" to Less Than 16"

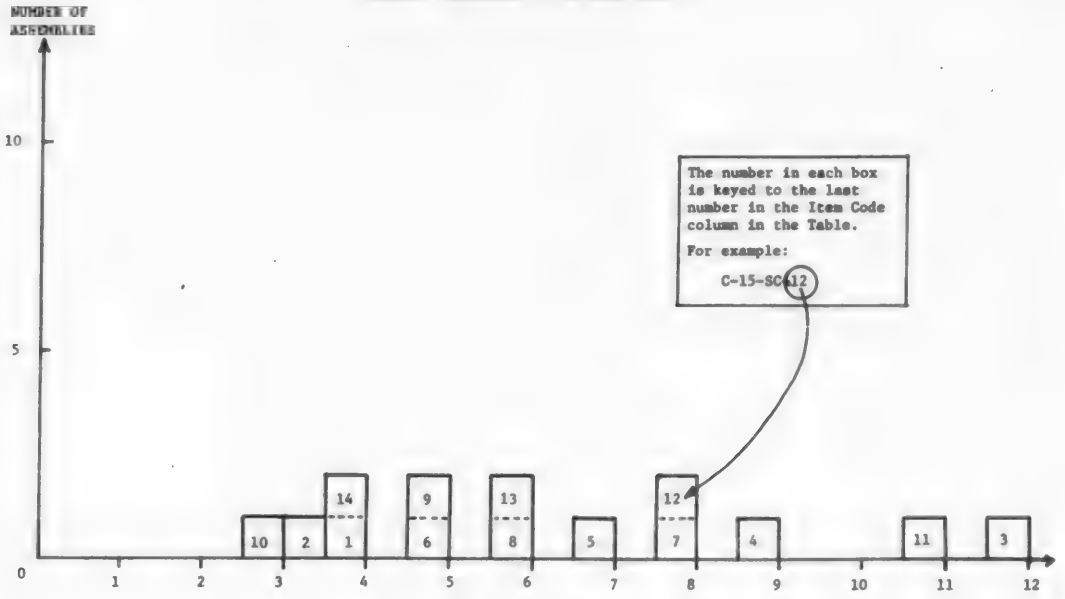


TABLE 2.5.1.6

STEEL COLUMNS - CONCRETE ENCASEMENTS

Minimum Dimension - 14" to Less Than 16"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-14-SC-1	14"	14" x 16" Concrete encased steel column; 8" x 6" x 35 lbs. H column; Protection - Aggregate concrete (4240 PSI) - 4" mesh - 16 S.W. G reinforcing - 1" below column surface.	90 tons	3 hr. 40min.			7	1	3
C-14-SC-2	14"	14" x 18" Concrete encased steel column; 12" x 8" x 65 lbs. "H" Beam; Protection - Gravel aggregate concrete (4000 PSI) with 4" - 16 S.W.G. wire mesh reinforcement 1" below column surface.	177 tons	3 hr. 20min.			7	1	3
C-14-SC-3	14"	10"x 10" steel column with 4" outside protection; Group I.	--	12 hrs		1		2	12
C-14-SC-4	14"	Description as per C-14-SC-3; Group II.	--	9 hrs		1		2	9
C-14-SC-5	14"	Description as per C-14-SC-3; Group III.	--	7 hrs		1		2	7
C-14-SC-6	14"	Description as per C-14-SC-3; Group IV.	--	5 hrs		1		2	5
C-14-SC-7	14"	12"x 12" steel column with 2" outside protection; Group I.	--	8 hrs		1		2	8
C-14-SC-8	14"	Description as per C-14-SC-7; Group II.	--	6 hrs		1		2	6

2.5.1.6 (cont'd)

Minimum Dimension - 14" to Less Than 16"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
C-14-SC-9	14"	Description as per C-14-SC-7; Group III.	--	5 hrs		1		2	5
C-14-SC-10	14"	Description as per C-14-SC-7; Group IV.	--	3 hrs		1		2	3
C-15-SC-11	15"	12"x 12" steel column with 3" outside protection; Group I.	--	11 hrs		1		2	11
C-15-SC-12	15"	Description as per C-15-SC-11; Group II.	--	8 hrs		1		2	8
C-15-SC-13	15"	Description as per C-15-SC-11; Group III.	--	6 hrs.		1		2	6
C-15-SC-14	15"	Description as per C-15-SC-11; Group IV.	--	4 hrs.		1		2	4

TABLE 2.5.1.6

NOTES

1. Collapse.

2. Group I - includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-includes concrete having cinder, sandstone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.

TABLE 2.5.1.7

STEEL COLUMNS - CONCRETE ENCASEMENTS

Minimum Dimension 16" to Less Than 18"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-16-SC-1	16"	12"x 12" steel column with 4" outside protection; Group I.	--	14 hr		1		1	14
C-16-SC-2	16"	Description as per C-16-SC-1; Group II.	--	10 hr		1		1	10
C-16-SC-3	16"	Description as per C-16-SC-1; Group III.	--	8 hrs		1		1	8
C-16-SC-4	16"	Description as per C-16-SC-1; Group IV.	--	5 hrs		1		1	5

TABLE 2.5.1.7

NOTES

1. Group I - includes concrete having calcareous aggregate containing a combined total of not more than 10 percent of quartz, chert and flint for the coarse aggregate.

   Group II- includes concrete having trap-rock aggregate applied without metal ties and also concrete having cinder, sandstone, or granite aggregate, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2, placed not more than 1 in. from the surface of the concrete.

   Group III-includes concrete having cinder, sandstone, or granite aggregate tied with No. 5 gage steel wire, wound spirally over the column section on a pitch of 8 in., or equivalent ties, and concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, if held in place with wire mesh or expanded metal having not larger than 4-in. mesh, weighing not less than 1.7 lb/yd^2 placed not more than 1 in. from the surface of the concrete.

   Group IV- includes concrete having siliceous aggregates containing a combined total of 60 percent or more of quartz, chert, and flint, and tied with No. 5 gage steel wire wound spirally over the column section on a pitch of 8 in., or equivalent ties.

TABLE 2.5.2.1

STEEL COLUMNS - BRICK & BLOCK ENCASEMENTS

Minimum Dimension 10" to Less Than 12"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	1st-BMS-92		
C-10-SB-1	10½"	10½"x 13" Brick encased steel columns;8"x 6"x 35 lb. "H" Beam; Protection: Fill of broken brick and mortar; 2" brick on edge, joints broken in alt. courses. Cement-sand grout; 13 SWG wire reinforcement in every third Horizontal joint.	90 tons	3 hr. 6 min.			7	1	3
C-10-SB-2	10½"	10½"x 13" brick encased steel columns;8"x 6"x 35 lb. "H" beam; Protection: 2" brick, joints broken in alt. courses; Cement-sand grout; 13 SWG iron wire reinforcement in alternate horizontal joints.	90 tons	2 hr.			7	2-4	2
C-10-SB-3	10"	10"x 12" block encased column; 8"x 6"x 35lb. "H" beam; Protection: 2" foamed slag concrete blocks; 13 SWG wire at each horizontal joint; mortar at each joint.	90 tons	2 hr.			7	5	2
C-10-SB-4	10½"	10½" x 12" block encased steel column; 8"x 6" x 35 lb. "H" beam; Protection: Gravel aggregate concrete fill (unconsolidated) 2" thick hollow clay tiles with mortar at edges.	86 tons	56min.			7	1	3/4
C-10-SB-5	10½"	10½" x 12" block encased steel column; 8"x 6" x 35 lb. "H" beam; Protection: 2" hollow clay tiles with mortar at edges.	86 tons	22min.			7	1	1/4

TABLE 2.5.2.1

NOTES

1. Failure mode - collapse.
2. Passed 2 hr. fire test (Grade "C" British).
3. Passed hose stream test.
4. Passed reload test.
5. Passed 2 hour fire exposure but collapsed immediately following hose stream test.

TABLE 2.5.2.2

STEEL COLUMNS - BRICK & BLOCK ENCASEMENTS

Minimum Dimension 12" to Less Than 14"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-12-SB-1	12"	12" x 15" brick encased steel columns; 8"x 6" x 35 lb. "H" beam; Protection: 2-5/8" thick brick; joints broken in alt. courses; Cement-sand grout. Fill of broken brick and mortar.	90 tons	1 hr. 49 min.			7	1	1-3/4

TABLE 2.5.2.2

NOTES

1. Failure mode - collapse.

TABLE 2.5.2.3

STEEL COLUMNS - BRICK & BLOCK ENCASEMENTS

Minimum Dimension 14" to Less Than 16"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-15-SB-1	15"	15" x 17" brick encased steel columns; 8" x 6"x 35 lb. "H" beam; Protection: 4-1/2" thick brick; joints broken in alt. courses; Cement-sand grout; Fill of broken brick and mortar	45 tons	6 hr.			7	1	6
C-15-SB-2	15"	15"x 17" brick encased steel columns; 8"x 6"x 35 lb. "H" beam; Protection: Fill of broken brick and mortar; 4½" brick, joints broken in alt. courses; Cement-sand grout.	86 tons	6 hr.			7	2-4	6
C-15-SB-3	15"	15"x 18" brick encased steel columns; 8"x 6"x 35 lb. "H" beam; Protection: 4½" brick work; joints alternating; Cement-sand grout.	90 tons	4 hr.			7	5,6	4
C-14-SB-4	14"	14"x 16" block encased steel columns; 8"x 6"x 35 lb. "H" beam; Protection: 4" thick foam slag concrete blocks; 13 SWG wire reinforcement in each horizontal joint; mortar in joints.	90 tons	5 hr. 52min.			7	7	4-3/4

TABLE 2.5.2.3

NOTES

1. Only a nominal load was applied to specimen.
2. Passed 6 hr. fire test (Grade "A" - British).
3. Passed (6 min.) hose stream test.
4. Reload not specified.
5. Passed 4 hour fire exposure.
6. Failed by collapse between 1st and 2nd minute of hose stream exposure.
7. Mode of failure - collapse.

TABLE 2.5.3.1

STEEL COLUMNS - PLASTER ENCASEMENTS

Minimum Dimension - 6" to Less Than 8"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-7-SP-1	7½"	7½"x 9½" Plaster protected steel columns; 8"x 6" x 35 lb. "H" beam; Protection: 24 SWG wire metal lath; 1¼" lime plaster.	90 tons	57min.			7	1	3/4
C-7-SP-2	7-7/8"	7-7/8"x 10" plaster protected steel columns; 8"x 6"x 35 lb. "H" beam; Protection: 3/8" gypsum bal. wire wound with 16 SWG wire helically wound @ 4" pitch; ½" gypsum plaster.	90 tons	1 hr. 13min.			7	1	1
C-7-SP-3	7¼"	7¼"x 9-3/8" plaster protected steel columns; 8"x 6"x 35 lb "H" beam; Protection: 3/8" gypsum board; wire helically wound 16 SWG @ 4" pitch; ½" gypsum plaster finish.	90 tons	1 hr. 14min.			7	1	1

TABLE 2.5.3.1

NOTES

1. Failure mode - collapse.

TABLE 2.5.3.2

STEEL COLUMNS - PLASTER ENCASEMENTS

Minimum Dimension - 8" to Less Than 10"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-8-SP-1	8"	8"x 10" plaster protected steel columns; 8"x 6" x 35 lb. "H" beam; Protection: 24 SWG wire lath with 1" gypsum plaster.	86 tons	1 hr. 23min.			7	1	1½
C-8-SP-2	8½"	8½"x 10½" plaster protected steel columns 8"x 6"x 35 lb."H" beam; Protection: 24 SWG metal lath wrap; 1¼" gypsum plaster.	90 tons	1 hr. 36min.			7	1	1½
C-9-SP-3	9"	9"x 11" plaster protected steel columns; 8"x 6"x 35 lb. "H" beam; Protection: 24 SWG metal lath wrap; 1/8" M.S. ties at 12" pitch wire netting 1½" x 22 SWG between 1st and 2nd plaster coats; 1½" gypsum plaster.	90 tons	1 hr. 33min.			7	1	1½
C-8-SP-4	8-3/4"	8-3/4"x 10-3/4" plaster protected steel columns 8"x 6"x 35 lb. "H" beam; Protection: 3/4" gypsum board - wire wound spirally (#16 SWG) @ 1½" pitch; ½" gypsum plaster.	90 tons	2 hr.			7	2-4	2

TABLE 2.5.3.2

NOTES

1. Failure mode - collapse.
2. Passed 2 hr. fire exposure test (Grade "C" - British).
3. Passed hose stream test.
4. Passed reload test.

TABLE 2.5.4.1

STEEL COLUMNS - MISCELLANEOUS ENCASEMENTS

Minimum Dimension 6" to Less Than 8"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Hrs Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-7-SM-1	7-5/8"	7-5/8"x 9½" (Asbestos plaster) protected steel columns;8"x 6"x 35 lb. "H" beam; Protection: 20 Ga. ½" metal lath; 9/16" asbestos plaster (min.)	90 tons	1 hr. 52min.			7	1	1-3/4

TABLE 2.5.4.1

NOTES

1. Failure mode - collapse.

TABLE 2.5.4.2

STEEL COLUMNS - MISCELLANEOUS ENCASEMENTS

Minimum Dimension 8" to Less Than 10"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Hrs Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-9-SM-1	9-5/8"	9-5/8"x 11-3/8" Asbestos slab and cement plaster protected columns;8"x 6"x 35 lb. "H" beam; Protection: 1" asbestos slabs, wire wound, 5/8" plaster.	90 tons	2 hr.			7	1,2	2

TABLE 2.5.4.2

NOTES

1. Passed 2 hr. fire exposure test.

2. Collapsed during hose stream test.

TABLE 2.5.4.3

STEEL COLUMNS - MISCELLANEOUS ENCASEMENTS

Minimum Dimension 10" to Less Than 12"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-11-SM-1	11½"	11½"x 13½" Wood wool and plaster protected steel columns;8" x 6" x 35 lb. "H" beam; Protection: Wood-wool-cement paste as fill and to 2" cover over beam; 3/4" gypsum plaster finish.	90 tons	2 hr.			7	1-3	2
C-10-SM-2	10"	10"x 12" asbestos protected steel columns;8"x 6"x 35 lb. "H" beam; Protection: sprayed on asbestos paste to 2" cover over column.	90 tons	4 hr.			7	2-4	4

TABLE 2.5.4.3

NOTES

1. Passed 2 hr. fire exposure (Grade "C" - British).
2. Passed hose stream test.
3. Passed reload test.
4. Passed 4-hour fire exposure test.

TABLE 2.5.4.4

STEEL COLUMNS - MISCELLANEOUS ENCASEMENTS

Minimum Dimension 12" to Less Than 14"

Item Code	Minimum Dimension	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
C-12-SM-1	12"	12"x 14½" Cement and asbestos protected column 8"x 6"x 35 lb. "H" beam; Protection: Fill of asbestos packing pieces 1" thick 1'3" O.C.; Cover of 2" molded asbestos inner layer; 1" molded asbestos, outer layer; held in position by 16 SWG nichrome wire ties; Wash of refractory cement on outer surface.	86 tons	4 hr. 43min.			7	1-3	4-2/3

TABLE 2.5.4.4

NOTES

1. Passed 4 hour fire exposure ("Grade B" - British)
2. Passed hose stream test.
3. Passed reload test.

SECTION III

FLOOR CEILING ASSEMBLIES

FIGURE 3.1

FLOOR/CEILING ASSEMBLIES - REINFORCED CONCRETE

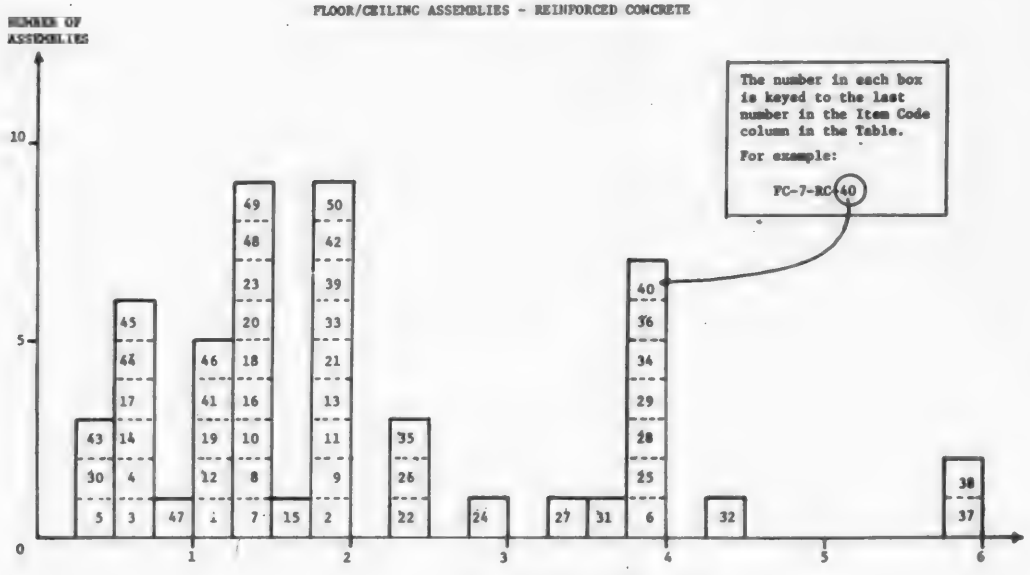


TABLE 3.1

Floor Ceiling Assemblies - Reinforced Concrete

Item Code	Assembly Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
FC-3-RC-1	3-3/4"	3-3/4" thick floor; 3½" (5475 PSI) concrete deck; ½" plaster under deck; 3/8" main rein. bars @ 5½" pitch with 7/8" concrete cover; 3/8" main rein. bars @ 4½" pitch perpendicular with ¾" concrete cover. 13'1" span restrained.	195 PSF	24min			7	1,2	1
FC-3-RC-2	3½"	3½" deep (3540 PSI) concrete deck; 3/8" main rein. bars @ 5½" pitch with 7/8" cover; 3/8" main rein. bars @ 4½" pitch perpendicular with ¾" cover. 13'1" span restrained.	195 PSF	2 hr.			7	1,3, 4	1-3/4
FC-3-RC-3	3½"	3½" deep (4175 PSI) concrete deck; 3/8" main rein. bars @ 5½" pitch with 7/8" cover; 3/8" main rein. bars @ 4½" pitch perpendicular with ¾" cover; 13'1" span restrained.	195 PSF	31min			7	1,5	¼
FC-3-RC-4	3½"	3½" deep (4355 PSI) concrete deck; 3/8" main rein. bars @ 5½" pitch with 7/8" cover; 3/8" main rein. bars @ 4½" pitch perpendicular with ¾" cover; 13'1" span restrained.	195 PSF	41min			7	1,5, 6	¼
FC-3-RC-5	3½"	3½" thick (3800 PSI) concrete deck; 3/8" main rein. bars @ 5½" pitch with 7/8" cover; 3/8" main rein. bars @ 4½" pitch perpendicular with ¾" cover.; 13'1" span restrained.	195 PSF	1 hr. 5 min.			7	1,5	¼
FC-4-RC-6	4½"	4½" thick; 3½" concrete deck (4000 PSI); 1" sprayed asbestos lower surface; 3/8" main rein bars @ 5-7/8" pitch with 7/8" concrete cover; 3/8" main rein. bars @ 4½" pitch perpendicular with ¾" concrete cover; 13'1" span restrained.	195 PSF	4 hr.			7	1,7	4
FC-4-RC-7	4"	4" deck (5025 PSI); ½" rein bars @ 7½" pitch with 3/4" cover; 3/8" main rein. bars @ 3-3/4" pitch perpendicular with ½" cover; 13'1" span restrained.	140 PSF	1 hr. 16 min			7	1,2	1¼

TABLE 3.1 (cont'd)

Floor Ceiling Assemblies - Reinforced Concrete

Item Code	Assembly Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
FC-4-RC-8	4"	4" thick (4905 PSI) deck; ¼" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3-3/4" pitch perpendicular with ½" cover; 13' 1" span restrained.	100 PSF	1 hr. 23 min			7	1,2	1-1/3
FC-4-RC-9	4"	4" deep (4370 PSI); ¼" rein. bars @ 6" pitch with 3/4" cover; ¼" main rein. bars @ 4" pitch perpendicular with ½" cover; 13'1" span restrained.	150 PSF	2 hr.			7	1,3	2
FC-4-RC-10	4"	4" thick (5140 PSI) deck; ¼" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3-3/4" pitch perpendicular with ½" cover; 13'1" span restrained.	140 PSF	1 hr. 16 min			7	1,5	1½
FC-4-RC-11	4"	4" thick (4000 PSI) concrete deck; 3"x1½"x4 lb. R.S.J.; 2'6" C.R.S.; flush with top surface; 4"x6"x13 S.W.G. mesh rein. 1" from bottom of slab; 6'6" span restrained.	150 PSF	2 hr.			7	1,3	2
FC-4-RC-12	4"	4" deep (2380 PSI) concrete deck; 3"x 1½"x 4 lb R.S.J.; 2'6" C.R.S.; flush with top surface; 4"x6"x13 S.W.G. mesh rein. 1" from bottom surface; 6'6" span restrained.	150 PSF	1 hr. 3 min.			7	1,2	1
FC-4-RC-13	4½"	4½" thick (5200 PSI) deck; ¼" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3-3/4" pitch perpendicular with ½" cover; 13'1" span restrained.	140 PSF	2 hr.			7	1,3	2
FC-4-RC-14	4½"	4½" deep (2525 PSI) concrete deck; ¼" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3-3/8" pitch perpendicular with ½" cover; 13'1" span restrained.	150 PSF	42 min			7	1,5	2/3
FC-4-RC-15	4½"	4½" deep (4830 PSI) concrete deck; 1½"x No. 15 gauge wire mesh; 3/8" rein. bar @ 15" pitch with 1" cover; ½" main rein. bars @ 6" pitch perpendicular with ½" cover; 12' span simply supported.	75 PSF	1 hr. 32 min			7	1,8	1½
FC-4-RC-16	4½"	4½" deep (4595 PSI) concrete deck; ¼" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3½" pitch perpendicular with ½" cover; 12' span simply supported.	75 PSF	1 hr. 20 min			7	1,8	1-1/3
FC-4-RC-17	4½"	4½" deep (3625 PSI) concrete deck; ¼" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3½" pitch perpendicular with ½" cover; 12' span simply supported.	75 PSF	35 min			7	1,8	½
FC-4-RC-18	4½"	4½" deep (4410 PSI) concrete deck; ¼" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3½" pitch perpendicular with ½" cover; 12' span simply supported.	85 PSF	1 hr. 27 min			7	1,8	1-1/3
FC-4-RC-19	4½"	4½" deep (4850 PSI) deck; 3/8" rein. bars @ 15" pitch with 1" cover; ½" main rein. bars @ 6" pitch perpendicular with ½" cover; 12' span simply supported.	75 PSF	2 hr. 15 min			7	1,9	1½
FC-4-RC-20	4½"	4½" deep (3610 PSI) deck; ¼" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3½" pitch perpendicular with ½" cover; 12' span simply supported.	75 PSF	1 hr. 22 min			7	1,8	1-1/3
FC-5-RC-21	5"	5" deep; 4½" (5830 PSI) concrete deck; ½" plaster finish bottom of slab; ¼" rein. bars 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3½" pitch perpendicular with ½" cover; 12' span simply supported.	69 PSF	2 hr.			7	1,3	2
FC-5-RC-22	5"	4½" (5290 PSI) concrete deck; ½" plaster finish bottom of slab; ¼" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3½" pitch perpendicular with ½" cover; 12' span simply supported.	No Load	2 hr. 28 min			7	1,10, 11	2½
FC-5-RC-23	5"	5" Deep (3020 PSI) concrete deck; 3"x1½"x 4 lb. R.S.J.; 2' C.R.S with 1" cover on bottom and top flanges; 8' span restrained.	172 PSF	1 hr. 24 min			7	1,2, 12	1½

3.1 (cont'd)

Floor Ceiling Assemblies - Reinforced Concrete

Item Code	Assembly Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
FC-5-RC-24	5½"	5" (5180 PSI) concrete deck; ½" retarded plaster underneath slab; ½" rein. bars @ 7½" pitch with 1-3/8" cover; 3/8" main rein. bars @ 3½" pitch perpendicular with 1" cover; 12' span simply supported.	60 PSF	2 hr. 48min.			7	1,10	2-3/4
FC-6-RC-25	6"	6" deep (4800 PSI) concrete deck; ½" rein. bars @ 7½" pitch 7/8" cover; 3/8" main rein. bars @ 3½" pitch perpendicular with 7/8" cover; 13'1" span restrained.	195 PSF	4 hr.			7	1,7	4
FC-6-RC-26	6"	6" (4650 PSI) concrete deck; ½" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein bars @ 3½" pitch perpendicular with ½" cover; 13'1" span restrained.	195 PSF	2 hr. 23 min			7	1,2	2¼
FC-6-RC-27	6"	6" deep (6050 PSI) concrete deck; ½" rein. bars @ 7½" pitch with 7/8" cover; 3/8" main rein. bars @ 3½" pitch perpendicular with ½" cover; 13'1" span restrained.	195 PSF	3 hr. 30 min			7	1,10	3½
FC-6-RC-28	6"	6" deep (5180 PSI) concrete deck; ½" bars @ 8" pitch 3/4" cover; ½" bars @ 5½" pitch with ½" cover perpendicular; 13'1" span restrained.	130 PSF	4 hr.			7	1,7	4
FC-6-RC-29	6"	6" thick (4180 PSI) concrete deck; 4"x3"x 10 lb R.S.J.; 2'6" C.R.S. with 1" cover on both bottom and top flanges; 13'1" span restrained.	160 PSF	3 hr. 48 min			7	1,10	3-3/4
FC-6-RC-30	6"	6" thick (3720 PSI) concrete deck; 4"x3"x10 lb. R.S.J; 2'6" C.R.S. with 1" cover on both top & bottom flanges; 12' span simply supported.	115 PSF	29 min			7	1,5, 13	¼
FC-6-RC-31	6"	6" deep (3450 PSI) concrete deck; 4"x 1-3/4" x 5 lb. R.S.J; 2'6" C.R.S. with 1" cover on both top and bottom flanges; 12' span simply supported.	25 PSF	3 hr. 35 min			7	1,2	3½
FC-6-RC-32	6"	6" deep (4460 PSI) concrete deck; 4"x 1-3/4" x 5 lb. R.S.J; 2' C.R.S; with 1" cover on both top and bottom flanges; 12'span simply supported.	60 PSF	4 hr. 30 min			7	1,10	4½
FC-6-RC-33	6"	6" deep (4360 PSI) concrete deck; 4"x1-3/4"x5 lb. R.S.J; 2' C.R.S; 1" cover on both bottom & top flanges; 13'1" span restrained.	60 PSF	2 hr.			7	1,3	2
FC-6-RC-34	6½"	6½" thick; 4-3/4" (5120 PSI) concrete core; 1" T&G board flooring; ½" plaster undercoat; 4"x 3"x 10 lb. R.S.J; 3' C.R.S. flush with top surface concrete 12' span simply supported; 2"x 1' 3" clinker concrete insert.	100 PSF	4 hr.			7	1,7	4
FC-6-RC-35	6½"	4-3/4" (3600 PSI) concrete core; 1" T&G board flooring; ½" plaster undercoat; 4"x 3"x 10 lb. R.S.J; 3' C.R.S; flush with top surface concrete; 12' span simply supported; 2"x1'3" clinker concrete insert.	100 PSF	2 hr. 30 min			7	1,5	2½
FC-6-RC-36	6½"	4-3/4" (2800 PSI) concrete core; 1" T&G board flooring; ½" plaster undercoat; 4"x 3"x 10 lb. R.S.J; 3' C.R.S; flush with top surface concrete; 12' span simply supported; 2"x 1'3" clinker concrete insert.	80 PSF	4 hr.			7	1,7	4
FC-7-RC-37	7"	(3640 PSI) concrete deck; ½" rein. bars @ 6" pitch 1½" cover; ½" rein. bars @ 5" pitch 1½" cover perpendicular; 13'1" span restrained.	169 PSF	6 hr.			7	1,14	6
FC-7-RC-38	7"	(4060 PSI) concrete deck; 4"x3"x10 lb. R.S.J. 2'6" C.R.S. with 1½" cover on both top & bottom flanges; 4"x6"x13 S.W.G. mesh rein. 1½" from bottom of slab; 13'1" span restrained.	175 PSF	6 hr.			7	1,14	6
FC-7-RC-39	7½"	5-3/4" (4010 PSI) concrete core; 1" T&G board flooring; ½" plaster undercoat; 4"x3"x10 lb. R.S.J., 2'6" C.R.S.; 1" down from top surface of concrete; 12' simply supported span; 2"x1'3" clinker concrete insert.	95 PSF	2 hr.			7	1,3	2
FC-7-RC-40	7½"	5-3/4" (3220 PSI) concrete core; 1" T&G board flooring; ½" plaster undercoat; 4"x3"x10 lb. R.S.J.; 2'6" C.R.S.; 1"down from top surface of concrete; 12' simply supported span; 2"x1'3" clinker concrete insert.	95 PSF	4 hr.			7	1,7	4

3.1 (cont'd)

Floor Ceiling Assemblies - Reinforced Concrete

Item Code	Assembly Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
FC-7-RC-41	10" (2½" Slab)	Ribbed floor - see detail - Note #15; Slab 2½" deep (3020 PSI); ½" rein. bars @ 6" pitch with 3/4" cover; Beams 7½" deep x 5" wide; 24" CRS; 5/8" rein. bars 2 rows ½" vertically apart with 1" cover; 13'1" span restrained.	19$ PSF	1 hr. 4 min.			7	1,2, 15	1
FC-5-RC-42	5½"	Composite ribbed concrete slab assembly; See note #17 for details.	See Note 16	2 hr.			43	16,17	2
FC-3-RC-43	3"	2500 PSI concrete, 5/8" cover; fully restrained at test	See Note 16	30 min			43	16	½
FC-3-RC-44	3"	2000 PSI concrete; 5/8" cover; free or partial restraint at test.	See Note 16	45 min			43	16	3/4
FC-4-RC-45	4"	2500 PSI concrete, 5/8" cover; fully restrained at test.	See Note 16	40 min			43	16	2/3
FC-4-RC-46	4"	2000 PSI concrete, 3/4" cover; free or partial restraint at test.	See Note 16	1 hr. 15 min			43	16	1¼
FC-5-RC-47	5"	2500 PSI concrete; 3/4" cover; fully restrained at test.	See Note 16	1 hr.			43	16	1
FC-5-RC-48	5"	2000 PSI concrete, 3/4" cover; free or partial restraint at test.	See Note 16	1 hr. 30 min			43	16	1½
FC-6-RC-49	6"	2500 PSI concrete; 1" cover; fully restrained at test.	See Note 16	1 hr. 30 min			43	16	1½
FC-6-RC-50	6"	2000 PSI concrete, 1" cover free or partial restraint at test.	See Note 16	2 hrs.			43	16	2

TABLE 3.1

NOTES

1. British test.
2. Failure mode - local back face temperature rise.
3. Tested for grade "C" (2 hr.) fire resistance.
4. Collapse immenent following hose stream.
5. Failure mode: flame-thru.
6. Void formed with explosive force and report.
7. Achieved grade "B" (4 hour) fire resistance (British).
8. Failure mode - collapse.
9. Test was run to 2 hr., but specimen was partially supported by the furnace at 1½ hrs.
10. Failure mode: average back face temperature.

3.1 (cont'd)

NOTES

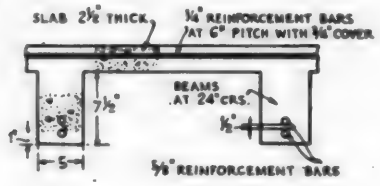
11. Recommended endurance is for non-load bearing performance only.

12. Floor maintained load-bearing ability to 2 hours at which point test was terminated.

13. Test was run to 3 hours at which time failure mode 2 (above) was reached in spite of crack formation at 29 min.

14. Tested for grade "A" (6 hour) fire resistance.

15.

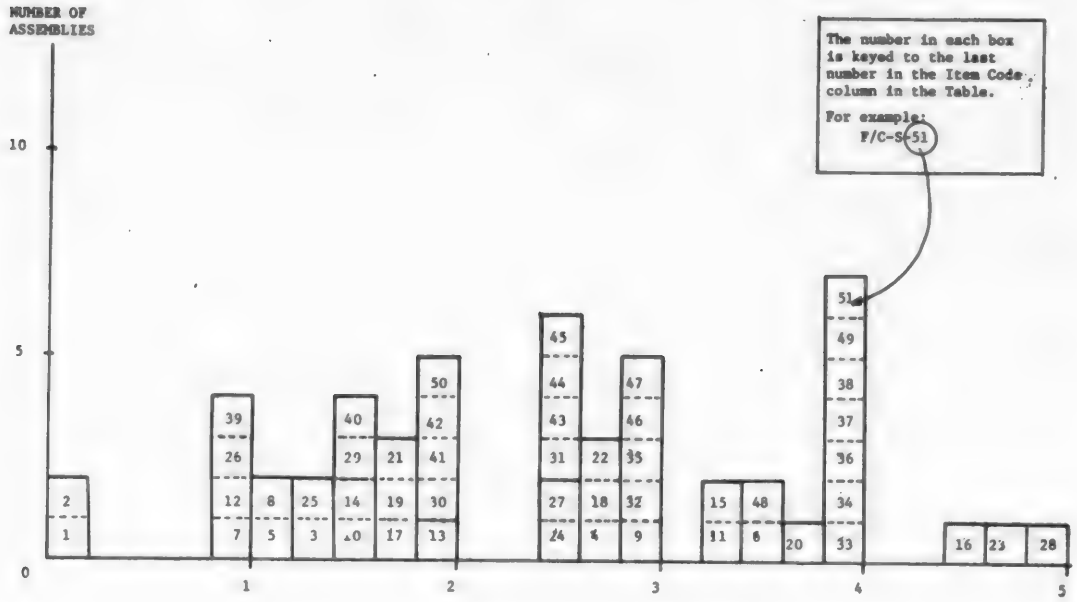


16. Load unspecified.

17. Total assembly thickness 9½". 3" thick blocks of molded excelsior bonded with portland cement used as inserts with 2½" cover (concrete) above blocks and 3/4" gypsum plaster below. 9" wide ribs containing reinforcing steel of unspecified size interrupted 20" wide segments of slab composite (i.e. plaster, excelsior blocks, concrete cover).

FIGURE 3.2

FLOOR/CEILING ASSEMBLIES STEEL STRUCTURAL ELEMENTS



FIRE RESISTANCE RATING (HOURS)

TABLE 3.2

FLOOR/CEILING ASSEMBLIES

STEEL STRUCTURAL ELEMENTS

Item Code	Membrane Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
F/C-S-1	0"	- 10'x 13'6"; S.J. 103-24" O.C.; Deck 2" concrete; Membrane: None.	145 PSF	7 min.			3	1,2,3 8	0
F/C-S-2	0"	- 10'x 13'6" S.J. 103-24" O.C.; Deck 2" concrete; Membrane: None.	145 PSF	7 min.			3	1,2,3 8	0
F/C-S-3	½"	- 10'x 13'6"; S.J. 103-24" O.C.; Deck 2" concrete 1:2:4; Membrane - 12" O.C. furring clips - ABG; No extra reinforcement; Plaster ½" 1.5:2.5	145 PSF	1 hr. 15min.			3	2,3,8	1¼
F/C-S-4	½"	- 10'x 13'6"; S.J. 103-24" O.C.; Deck 2" concrete 1:2:4; membrane - 16" O.C. furring clips - DEFG; Diagonal wire reinforcement; ½" plaster 1.5:2.5	145 PSF	2 hr. 46min.			3	3,8	2-3/4
F/C-S-5	½"	- 10'x 13'6" S.J. 103-24" O.C.; Deck 2" concrete 1:2:4; membrane - furring 16" O.C.; Clip A,B,G; No extra reinforcement; Plaster ½" 1.5:2.5.	145 PSF	1 hr. 4 min.			3	2,3,8	1
F/C-S-6	½"	10'x 13'6"; S.J. 103-24" O.C.; Deck 2" concrete 1:2:4; Membrane - furring 16" O.C.; Clips - DEFG; Hexagonal mesh reinforcement ½" plaster	145 PSF	3 hr. 28min.			3	2,4,8	2-1/3

3.2 (cont'd)

STEEL STRUCTURAL ELEMENTS

Item Code	Membrane Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
F/C-S-7	½"	10'x 13'6"; S.J. 103-24" O.C.; Deck 4 lb rib lath; 6"x 6"-10x 10 ga. reinforcement; 2" deck gravel concrete; Membrane - furring 16" O.C.; clips - C.E.; Reinforcement - No.; 1/2" plaster - 1.5:2.5 mill mix.	N/A	55min.			3	5,8	3/4
F/C-S-8	½"	spec. 9'x 4'4"; S.J. 103 Bar Joists - 18" O.C.; Membrane: Furring - 3/4" C.R.S. - 16" O.C.; clips - C,E; Reinforcement - No ; 1/2" plaster - 1.5:2.5 mill mix; Deck: 4 lb. rib lath base; 6"x 6" - 10x 10 ga. reinforcement; 2" deck 1:2:4 gravel concrete.	300 PSF	1 hr. 10min.			3	2,3,8	1
F/C-S-9	5/8"	10'x 13'6"; S.J. 103-24" O.C.; Deck 2" concrete 1:2:4; Membrane: furring 12" O.C.; Clips ABC; Extra "A" clips reinforcement; 5/8" plaster - 1.5:2; 1.5:3.	145 PSF	3 hr.			3	6,8	3
F/C-S-10	5/8"	18'x13'6"; Joists - S.J. - 103-24"O.C.; Deck: 4 lb. rib lath; 6"x 6" - 10x 10 ga. reinforcement; 2" deck - 1:2:3.5 gravel concrete Membrane - furring, spacing - 16" O.C.; clips C.E.; Reinforcement - No ; 5/8" plaster - 1.5:2.5 mill mix.	145 PSF	1 hr. 25min.			3	2,3,8	1-1/3
F/C-S-11	5/8"	10'x 13'6", S.J. 103 - 24" O.C.; Deck 2" concrete 1:2:4; Membrane: furring 12" O.C.; clips - D.E.F.G., Diagonal wire reinforcement; 5/8" plaster - 1.5:2; 0.5:3	145 PSF	3 hr. 15min.			3	2,4,8	3½
F/C-S-12	5/8"	10'x13'6"; Joists -SJ 103 - 24" OC; Deck: 3.4 lb. rib lath; Reinforcement - 6"x6" 10 x 10 ga.; 2" deck - 1:2:4 gravel concrete; Membrane: furring 16" O.C.; Clips - D,E,F,G; No reinforcement; 5/8" plaster - 1.5:2.5.	145 PSF	1 hr.			3	7,8	1
F/C-S-13	3/4"	Spec. 9'x 4'4"; SJ 103 - 18" O.C.; Deck - 4lb. rib. lath; 6"x6" - 10 x 10 ga. reinforcement; 2" deck 1:2:4 gravel concrete; Membrane - furring 3/4" CRS 16" O.C.; Clips - C,E; Reinforcement - None; 3/4" plaster - 1.5:2.5 mill mix	300 PSF	1 hr. 56min.			3	3,8	1-3/4
F/C-S-14	7/8"	Floor finish - 1" concrete; plate cont. weld; 4" - 7.7 lb. I beams; Ceiling - ½" rods 12" O.C.; 7/8" gyp. sand plaster.	105 PSF	1 hr. 35min.			5	2,4,9 10	1-1/2
F/C-S-15	1"	floor finish - 1½" L.W. concrete; ½" limestone cement; plate cont. weld; 5" - 10 lb. I beams; Ceiling - ½" rods - 12" O.C. Tack welded to beams metal lath - 1" P.C. plaster.	165 PSF	3 hr. 20min.			5	4,9,11	
F/C-S-16	1"	10'x 13'6"; SJ 103 - 24" .C.; Deck: 2" concrete - 1:2:4; Membrane: furring 12" O.C.; clips D,E,F,G; Plaster - hexagonal mesh reinforcement; 1" thick - 1.5:2; 1.5:3.	145 PSF	4 hr. 26min			3	2,4,8	4-1/3
F/C-S-17	1"	10'x13'6"; Joists - SJ 103 - 24" O.C.; Deck 3.4 lb. rib lath; Reinforcement: 6"x6" - 10x10 ga.; 2" deck 1:2:4 gravel concrete; Membrane: furring 16"O.C.; clips D,E,F,G; 1" plaster	145 PSF	1 hr. 42min.			3	2,4,8	1-2/3
F/C-S-18	1-1/8"	10'x13'6" S.J. 103 - 24" O.C.; Deck: 2" concrete 1:2:4; Membrane: furring 12" O.C.; clips C,E,F,G; Diag. wire reinforcement; 1-1/8" plaster.	145 PSF	2 hr. 44min			3	2,4 8	2-2/3
F/C-S-19	1-1/8"	10'x13'6"; Joists - S.J. 103 - 24" O.C. Deck - 1½" Gypsum concrete over; ½" gypsum board base; Membrane furring 12" O.C. Plaster 1-1/8" 1.5:2; 1.5:3; Clips D,E,F,G.	145 PSF	1 hr. 40min			3	2,3,8	1-2/3
F/C-S-20	1-1/8"	2½" cinder concrete; ½" topping; plate 6." welds 12" O.C.; 5" - 18.9 lb. "I" center; 5" - 10 lb "I" ends; 1" channel 18" O.C.; 1-1/8" gypsum sand plaster.	150 PSF	3 hr. 43min			5	2,4,9 11	3-2/3
F/C-S-21	1½"	10'x 13'6"; Joists - SJ 103 - 24" O.C.; Deck: 1½" gypsum concrete over; ½" gypsum board base; Membrane: furring 12" O.C. Clips D,E,F,G; 1½" plaster 1.5:2; 1.5:3.	145 PSF	1 hr. 48min			3	2,3,8	1-2/3

3.2 (cont'd)

STEEL STRUCTURAL ELEMENTS

Item Code	Membrane Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
F/C-S-22	1½"	Floor finish 1½" limestone concrete; ½" sand cement topping; plate to beam 3½"; 12" O.C. welded; 5" 10 lb "I" beam; 1" channels 18" O.C.; 1½" wood fiber gypsum sand plaster on metal lath.	292 PSF	2 hr. 45min			6	2,4,9 10	2-3/4
F/C-S-23	1½"	2½" L.W. (gas. exp.) concrete; Deck: 1/2" topping; plate 6⅛" welds 12" O.C.; Beams: 5"-18.9 lb. "H" center; 5"-10 lb. "I" ends; Membrane: 1" channel 18" OC; 1½" gyp. sand plaster.	150 PSF	4 hr. 42min			6	2,4,9	4-2/3
F/C-S-24	1½"	floor finish 1½" limestone concrete; ½" cement topping; plate 3½" - 12" O.C. welded; 5" - 10 lb "I" beam; Ceiling: 1" channel - 18" O.C.; 1½" gypsum plaster.	292 PSF	2 hr. 34min			6	2,4,9 10	2½
F/C-S-25	1½"	floor finish 1½" gravel concrete on exp. metal; plate - cont. weld; 4" 7.7 lb. "I" beams; Ceiling ½" rods - 12"O.C. welded to beams; 1½" fiber gypsum sand plaster.	70 PSF	1 hr. 24min.			6	2,4,9, 10	1-1/3
F/C-S-26	2½"	floor finish - bare plate; 6⅛" welding - 12" O.C.; 5"-18.9 lb. "H" girden (inner); 5" 10 lb. "I" girder (2 outer); 1" channel 18" O.C 2" reinforced gypsum tile; ½" gypsum sand plaster.	122 PSF	1 hr.			6	7,9, 11	1
F/C-S-27	2½"	floor finish - 2" gravel concrete; plate to beam 3½ - 12" O.C. welded; 4" 7.7 lb. "I" beams; 2" gypsum ceiling tiles; ½" 1:3 gypsum sand plaster.	105 PSF	2 hr. 31 min			6	2,4,9 10	2½
F/C-S-28	2½"	floor finish - 1½" gravel concrete; ½" gypsum ashphalt; plate continuous weld 4"-7.7 lb. "I" beam; 12" 31.8 lb. "I" beam - girder @ 5' from 1 end; 1" channels 18" O.C.; 2" reinforcement gypsum tile; ½" 1:3 gypsum sand plaster.	200 PSF	4 hr. 55min			6	2,4,9 11	4-2/3
F/C-S-29	3/4"	Floor: 2" rein. concrete or 2" precast rein. gypsum tile; Ceiling: 3/4" portland cement sand plaster 1:2 scratch and 1:3 brown coat with 15 lb. hydrated lime and 3 lb. of short asbestos fiber bag per cement or 3/4" sanded gypsum plaster 1:2 scratch and 1:3 brown coat	See Note 12	1 hr. 30min		1		12,13 14	1 ½
F/C-S-30	3/4"	Floor: 2½" rein. concrete or 2" rein. gypsum tile; the latter with ½" mortar finish; Ceiling 3/4" sanded gypsum plaster; 1:2 for scratch coat and 1:3 for brown coat.	See Note 12	2 hrs		1		12,13 14	2
F/C-S-31	3/4"	Floor: 2½" rein. concrete or 2" rein. gypsum tile; the latter with ½" mortar finish; Ceiling: 1" neat gypsum plaster or 3/4" gypsum vermiculite plaster ratio of gypsum to fine vermiculite 2:1 to 3:1.	See Note 12	2 hrs 30min		1		12,13 14	2½
F/C-S-32	3/4"	Floor: 2½" rein. concrete or 2" rein. gypsum tile; the latter with ½" mortar finish; Ceiling 1" neat gypsum plaster or 3/4" gypsum-vermiculite plaster, ratio of gypsum to fine vermiculite 2:1 to 3:1	See Note 12	3 hrs		1		12,13 14	3
F/C-S-33	1"	Floor: 2½" rein. concrete, or 2" rein. gypsum slabs, the latter with ½" mortar finish; Ceiling: 1" gypsum vermiculite plaster applied on metal lath and ratio 2:1 to 3:1 gypsum to vermiculite by weight.	See Note 12	4 hrs		1		12,13 14	4
F/C-S-34	2½"	Floor: 2" rein. concrete or 2" precast rein. portland cement concrete or gypsum slabs, precast slabs to be finished with ½" mortar top coat; Ceiling: 2" precast reinforced gypsum tile, anchored into beams with metal ties or clips and covered with ½" 1:3 sanded gypsum plaster.	See Note 12	4 hrs.		1		12,13 14	4
F/C-S-35	1"	Floor: 1:3:6 portland cement, sand, and gravel concrete applied directly to the top of steel units and 1½" thick at top of cells, plus ½" 1:2½" cement-sand finish, total thickness at top of cells, 2"; Ceiling: 1" neat gypsum plaster, back of lath 2" or more from underside of cellular steel.	See Note 15	3 hrs.		1		15,16 17,18	3

3.2 (cont'd)

STEEL STRUCTURAL ELEMENTS

Item Code	Membrane Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
F/C-S-36	1"	Floor: Same as F/C-S-35 Ceiling: 1" gypsum vermiculite plaster (ratio of gypsum to vermiculite 2:1 to 3:1), the back of lath 2" or more from underside of cellular steel.	See Note 15	4 hrs.		1		15,16 17,18	4
F/C-S-37	1"	Floor: Same as F/C-S-35 Ceiling: 1" neat gypsum plaster; back of lath 9" or more from underside of cellular steel.	See Note 15	4 hrs		1		15,16 17,18	4
F/C-S-38	1"	Floor: Same as F/C-S-35 Ceiling: 1" gypsum vermiculite plaster (ratio of gypsum to vermiculite 2:1 to 3:1) the back of lath being 9" or more from underside of cellular steel.	See Note 15.	5 hrs.		1		15,16 17,18	5
F/C-S-39	3/4"	Floor: Asbestos paper 14 lb/100 ft.^{2} cemented to steel deck with waterproof linoleum cement, wood screeds and 7/8" wood floor; Ceiling: 3/4" sanded gypsum plaster 1:2 for scratch and 1:3 for brown coat.	Note 19	1 hr.		1		19,20 21,22	1
F/C-S-40	3/4"	Floor: 1½" 1:2:4 portland cement concrete; Ceiling: 3/4" sanded gypsum plaster 1:2 for scratch and 1:3 brown coat.	Note 19	1 hr. 30 min		1		19,20 21,22	1½
F/C-S-41	3/4"	Floor: 2", 1:2:4 portland cement concrete; Ceiling: 3/4" sanded gypsum plaster, 1:2 for scratch and 1:3 for brown coat.	Note 19	2 hrs.		1		19,20 12,22	2
F/C-S-42	1"	Floor: 2", 1:2:4 portland cement-concrete; Ceiling: 1" portland cement-sand plaster with 10 lb. of hydrated lime for @ bag of cement 1:2½ for brown coat. 1:2 scratch coat.	Note 19	2 hrs.		1		19,20 21,22	2
F/C-S-43	1½"	Floor: 2", 1:2:4 portland cement concrete; Ceiling: 1½", 1:2 sanded gypsum plaster on ribbed metal lath.	Note 19	2 hrs. 30 min		1		19,20 21,22	2½
F/C-S-44	1-1/8"	Floor: 2", 1:2:4 portland cement concrete; Ceiling: 1-1/8", 1:1 sanded gypsum plaster.	Note 19	2 hrs. 30 min		1		19,20 21,22	2½
F/C-S-45	1"	Floor: 2½", 1:2:4 portland cement concrete; Ceiling: 1", 1:2 sanded gypsum plaster.	Note 19	2 hrs. 30 min		1		19,20 21,22	2½
F/C-S-46	3/4"	Floor: 2½", 1:2:4 portland cement concrete; Ceiling: 1" neat gypsum plaster or 3/4" gypsum vermiculite plaster, ratio of gypsum to vermiculite 2:1 to 3:1	Note 19	3 hrs.		1		19,20 21,22	3
F/C-S-47	1-1/8"	Floor: 2½", 1:2:4 portland cement, sand and cinder concrete plus ½", 1:2½ cement-sand finish; total thickness 3"; Ceiling: 1-1/8", 1:1 sanded gypsum plaster.	Note 19	3 hrs.		1		19,20 21,22	3
F/C-S-48	1-1/8"	Floor: 2½" gas expanded portland cement-sand concrete plus ½", 1:2½ cement-sand finish; total thickness 3"; Ceiling; 1-1/8", 1:1 sanded gypsum plaster.	Note 19	3 hrs. 30 min		1		19,20 21,22	3½
F/C-S-49	1"	Floor: 2½", 1:2:4 portland cement concrete; Ceiling: 1" gypsum vermiculite plaster; ratio of gypsum to vermiculite 2:1 to 3:1.	Note 19	4 hrs.		1		19,20 21,22	4
F/C-S-50	2½"	Floor: 2", 1:2:4 portland cement concrete; Ceiling: 2" interlocking gypsum tile supported on upper face of lower beam flange, 1/2" 1:3 sanded gypsum plaster.	Note 19	2 hrs.		1		19,20 21,22	2
F/C-S-51	2½"	Floor: 2" 1:2:4 portland cement concrete; Ceiling: 2" precast metal rein. gypsum tile ½" 1:3 sanded gypsum plaster (tile clipped to channels which are clipped to lower flange of beams).	Note 19	4 hrs		1		19,20 21,22	4

TABLE 3.2

NOTES

1. No protective membrane over structural steel.

2. Performance time indicates first end point reached only several tests were continued to points where other failures occurred.

3. Load failure.

4. Thermal failure.

5. This is an estimated time to load bearing failure. The same joist and deck specimen was used for a later test with different membrane protection.

6. Test stopped at 3 hr. to reuse specimen; No endpoint reached.

7. Test stopped at 1 hour to reuse specimen; No endpoint reached.

8. All plaster used = gypsum.

9. Specimen size - 18'x 13½'. Floor Deck - base material - ¼" x 18' steel plate welded to "I" beam.

10. I beams - 24" O.C.

11. I beams - 48" O.C.

12. Apply to open web joists, pressed steel joists, or rolled steel beams, which are not stressed beyond 18,000 lb/in.^{2} in flexure for open-web pressed, or light rolled steel joists and 20,000 lb/in.^{2} for American standard or heavier rolled beams.

13. Ratio of weight of portland cement to fine and coarse aggregates combined for floor slabs shall not be less than 1:6½.

14. Plaster for ceiling shall be applied on metal lath which shall be tied to supports to give the equivalent of single No. 18 gage steel wires 5" O.C.

15. Load: Maximum fiber stress in steel not to exceed 16,000 PSI.

16. Prefabricated units 2 ft. wide with length equal to the span, composed of 2 pieces of No.18 gage formed steel welded together to give 4 longitudinal cells.

17. Depth not less than 3" and distance between cells not less than 2".

18. Ceiling: metal lath tied to furring channels secured to runner channels hung from cellular steel.

19. Load: Rolled steel supporting beams and steel plate base shall not be stressed beyond 20,000 PSI in flexure.

    Formed steel (with wide upper flange) construction shall not be stressed beyond 16,000 PSI.

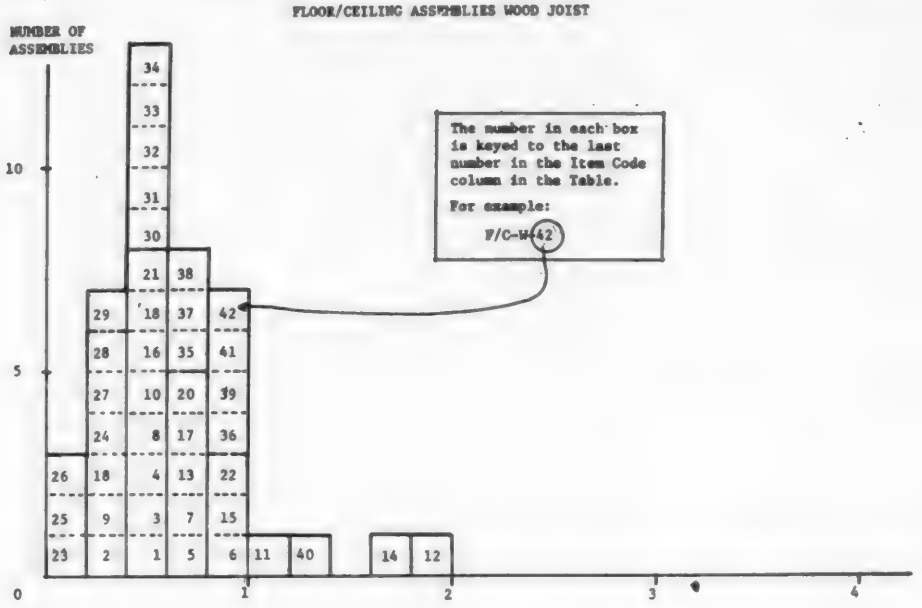
20. Some type of expanded metal or woven wire shall be imbedded to prevent cracking in concrete flooring.

21. Ceiling plaster shall be on metal lath wired to rods or channels which are clipped or welded to steel construction. Lath shall be no smaller than 18 gage steel wire and not more than 7" O.C.

22. The securing rods or channels shall be at least as effective as single 3/16" rods with 1" of their length bent over the lower flanges of beams with the rods or channels tied to this clip with 14 gage iron wire.

FIGURE 3.3

FLOOR/CEILING ASSEMBLIES WOOD JOIST



FIRE RESISTANCE RATING (HOURS)

TABLE 3.3

FLOOR/CEILING ASSEMBLIES

WOOD JOIST

Item Code	Membrane Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
F/C-W-1	3/8"	12' clear span - 2"x 9" wood joists - 18" O.C. Deck - 1" T&G; Filler: 3" of ashes on ½" boards nailed to joist sides 2" from bottom; 2" air space; Membrane 3/8" gypsum board.	60 PSF	36min.			7	1,2	½
F/C-W-2	½"	12' clear span - 2"x7" joists; 15" O.C.; 2"x 1½" center bridging at center; Deck - 1" nominal lumber; membrane - ½" fiber board.	60 PSF	22min.			7	1,2,3	½
F/C-W-3	½"	12' clear span - 2"x 7" wood joists, 16" O.C. 2"x1½" bridging at center; deck - 1" T&G; membrane - ½" fiberboard; 2 coats "distemper" paint.	30 PSF	30min			7	1,3	½
F/C-W-4	3/16"	12' clear span - 2"x 7" wood joists, 16" O.C. 2 x 1½ bridging at center span; Deck - 1" nominal lumber; membrane - ½" fiberboard under 3/16" gypsum plaster.	30 PSF	32min			7	1,2	½
F/C-W-5	5/8"	As per previous F/C-W-4 except membrane is 5/8" lime plaster.	70 PSF	48min			7	1,2	3/4
F/C-W-6	5/8"	As per previous F/C-W-5 except membrane is 5/8" gypsum plaster on 22 gauge 3/8" metal lath.	70 PSF	49min			7	1,2	3/4
F/C-W-7	½"	As per previous F/C-W-6 except membrane is ½" fiberboard under ½" gypsum plaster.	60 PSF	43min			7	1,2,3	2/3
F/C-W-8	½"	As per previous F/C-W-7 except membrane is ½" gypsum board.	60 PSF	33min			7	1,2,3	½

3.3 (cont'd)

FLOOR/CEILING ASSEMBLIES

WOOD JOIST

Item Code	Membrane Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
F/C-W-9	9/16"	12' clear span - 2"x 7" wood joists; 15" O.C. 2"x 1½" center bridging; Deck - 1" nominal lumber; membrane - 3/8" gypsum board; 3/16" gypsum plaster.	60 PSF	24min			7	1,2,3	1/3
F/C-W-10	5/8"	As per F/C-W-9 except membrane is 5/8" gypsum plaster on wood lath.	60 PSF	27min.			7	1,2,3	1/3
F/C-W-11	7/8"	12' clear span - 2"x 9" wood joists; 15" O.C. 2"x 1½" bridging at center span; Deck - 1" T&G Membrane - original ceiling joists have 3/8" plaster on wood lath. 4" metal hangers attached below joists creating 15" chases filled with mineral wood and closed with 7/8" plaster (gypsum) on 3/8" S.W.M. metal lath to form new ceiling surface.	75 PSF	1 hr. 10min.			7	1,2	1
F/C-W-12	7/8"	12' clear span - 2"x 9" wood joists - 15" O.C. 2"x 1½" bridging at center; Deck - 1" T&G; Membrane - 3" mineral wood below joists; 3" hangers to channel below joists; 7/8" gypsum plaster on metal lath attached to channels.	75 PSF	2 hr.			7	1,4	2
F/C-W-13	7/8"	12' clear span - 2"x 9" wood joists - 16" O.C. with 2" x 1½" bridging at center span; Deck - 1" T&G on 1" bottoms on 3/4" glass wool strips on 3/8" gypsum board nailed to joists; Membrane 3/4" glass wood strips on joists; 3/8" perf. gypsum lath; ½" gypsum plaster.	60 PSF	41min			7	1,3	2/3
F/C-W-14	7/8"	12' clear span - 2" x 9" wood joists - 15" O.C. Deck - 1" T&G; Membrane - 3" foam concrete in cavity on ½" boards nailed to joists; wood lath nailed to 1"x 1½" straps 14" O.C. across joists; 7/8" gypsum plaster.	60 PSF	1 hr. 40min.			7	1,5	1-2/3
F/C-W-15	7/8"	12' clear span - 2"x 9" wood joists - 18" O.C. Deck - 1" T&G; Membrane - 2" foam concrete on ½" boards nailed to joist sides 2" from joist bottom; 2" airspace; 1"x 1½" wood straps 14" O.C. across joists; 7/8" lime plaster on wood lath.	60 PSF	53min.			7	1,2	3/4
F/C-W-16	7/8"	12' clear span - 2"x 9" wood joists; Deck - 1" T&G; Membrane - 3" ashes on ½" boards nailed to joist sides 2" from joist bottom; 2" air space; 1"x 1½" straps (wood) 14" O.C.; 7/8" gypsum plaster on wood lath.	60 PSF	28min.			7	1,2	1/3
F/C-W-17	7/8"	As per previous F/C-W-16 but with lime plaster mix.	60 PSF	41min.			7	1,2	2/3
F/C-W-18	7/8"	12' clear span - 2"x 9" wood joists - 18" O.C. 2"x 1½" center bridging; Deck - 1" T&G; Membrane - 7/8" gypsum plaster on wood lath.	60 PSF	36min.			7	1,2	½
F/C-W-19	7/8	As per previous F/C-W-18 except with lime plaster membrane and deck is 1" nominal boards (plain edge).	60 PSF	19min.			7	1,2	½
F/C-W-20	7/8"	As per F/C-W-19 except deck is 1" T&G boards.	60 PSF	43min.			7	1,2	2/3
F/C-W-21	1"	12' clear span - 2" x 9" wood joists - 16" O.C. 2"x 1½" center bridging; deck - 1" T&G; Membrane - 3/8" gypsum base board; 5/8" gypsum plaster.	70 PSF	29min.			7	1,2	1/3
F/C-W-22	1-1/8"	12' clear span - 2"x 9" wood joists - 16" O.C. bridging - 2"x 2" wood at center; deck - 1" T&G; membrane - hangers, channel with 3/8" gypsum baseboard affixed under 3/4" gypsum plaster.	60 PSF	1 hr.			7	1,2,3	1
F/C-W-23	3/8"	Deck: 1" nominal lumber; Joists: 2"x 7", 15" O.C.; Membrane: 3/8" plasterboard with plaster skim coat.	60 PSF	11½ min.			12	2,6	1/6
F/C-W-24	½"	Deck: 1" T&G lumber; Joists: 2"x 9", 16" O.C.; Membrane: ½" plasterboard.	60 PSF	18 min			12	2,7	½
F/C-W-25	½"	Deck: 1" T&G lumber; Joists: 2"x 7", 16" O.C.; Memberane: ½" fiber insulation board.	30 PSF	8 min.			12	2,8	2/15

3.3 (cont'd)

FLOOR/CEILING ASSEMBLIES

WOOD JOIST

Item Code	Membrane Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
F/C-W-26	½"	Deck: 1" nominal lumber; Joists: 2"x 7", 15" O.C.; Membrane: ½" fiber insulation board.	60 PSF	8 min.			12	2,9	2/15
F/C-W-27	5/8"	Deck: 1" nominal lumber; Joists: 2"x 7", 15" O.C.; Mem.: 5/8" gypsum plaster on wood lath.	60 PSF	17 min			12	2,10	½
F/C-W-28	5/8"	Deck: 1" T&G lumber; Joists: 2"x 9", 16" O.C.; Mem.: ½" fiber insulation board; ½" plaster.	60 PSF	20 min			12	2,11	1/3
F/C-W-29	No Membrane	Exposed wood joists; no ceiling.	See Note 13	15 min		1		1,12, 13,14	½
F/C-W-30	3/8"	Gypsum wallboard- 3/8" or ½" with 1½" No. 15 gage nails with 3/16" heads spaced 6" centers with asbestos paper applied with paperhangers paste and finished with casein paint.	See Note 13	25 min		1		1,12 13,14	½
F/C-W-31	½"	Gypsum wallboard- ½" with 1-3/4" No.12 gage nails with ½" heads, 6" O.C. and finished with casein paint.	See Note 13	25 min		1		1,12, 13,14	½
F/C-W-32	½"	Gypsum wallboard- ½" with 1½" No. 12 gage nails with ½" heads, 18" C.C. with asbestos paper applied with paper hangers paste and secured with 1½" No. 15 gage nails with 3/16" heads and finished with casein paint; combined nail spacing 6" O.C.	See Note 13	30 min		1		1,12 13,14	½
F/C-W-33	3/8"	Gypsum wallboard- 2 layers 3/8" secured with 1½" No. 15 gage nails with 3/8" heads, 6" O.C.	See Note 13	30 min		1		1,12, 13,14	½
F/C-W-34	½"	3/8" perforated gypsum lath- plastered with 1-1/8" No. 13 gage nails with 5/16" heads; 4" O.C.; ½" sanded gypsum plaster.	See Note 13	30min.		1		1,12, 13,14	½
F/C-W-35	½"	Same as F/C-W-34. Except with 1-1/8" No. 13 gage nails with 3/8" heads; 4" O.C.	See Note 13	45 min		1		1,12, 13,14	3/4
F/C-W-36	½"	3/8" perforated gypsum lath nailed with 1-1/8" No. 13 nails with 3/8" heads; 4" O.C.; Joints covered with 3" strips of metal lath; with 1-3/4"; No. 12 nails with ½" heads; 5" O.C. ½" sanded gypsum plaster.	See Note 13	1 hr.		1		1,12, 13,14	1
F/C-W-37	½"	Gypsum lath - 3/8" and lower layer of 3/8" perforated gypsum lath nailed with 1-3/4" No. 13 nails with 5/16" heads and 4" O.C.; ½" sanded gypsum plaster or ½" portland cement plaster.	See Note 13	45 min		1		1,12 13,14	3/4
F/C-W-38	3/4"	Metal lath - nailed with 1½" NO. 11 nails with 3/8" heads or 6 d common driven 1" and bent over; 6" O.C.; 3/4" sanded gypsum plaster.	See Note 13	45 min		1		1,12 13,14	3/4
F/C-W-39	3/4"	Same as F/C-W-38 except nailed with 1½" No. 11 barbed roof nails with 7/16" heads, 6" O.C.	See Note 13	1 hr.		1		1,12 13,14	1
F/C-W-40	3/4"	Same as F/C-W-38 except with lath nailed to joists with additional supports for lath 27" O.C.; attached to alternate joists and consisting of 2 nails driven 1½", 2" above bottom on opposite sides of the joists, one loop of No 18 wire slipped over each nail; the ends twisted together below lath.	See Note 13	1 hr. 15 min		1 1		1,12, 13,14	1½
F/C-W-41	3/4"	Metal lath with 1½" No.11 barbed roof nails with 7/16" heads, 6" O.C. with 3/4" portland cement plaster for scratch and 1:3 for brown coat, 3 lb. of asbestos fiber and 15 lb. of hydrated lime/94 lb. bag of cement.	See Note 13	1 hr.		1		1,12, 13,14	1
F/C-W-42	3/4"	Metal lath nailed with 8d, 11½ gage barbed box nails 2½" driven 1½" on slant and bent over; 6" O.C.; 3/4" sanded gypsum plaster 1:2 scratch coat and 1:3 below coat.	See Note 13	1 hr.		1		1,12, 13,14	1

TABLE 3.3

NOTES

1. Thickness indicates thickness of first membrane protection on ceiling surface.
2. Failure mode - flame thru.
3. Failure mode - collapse.
4. No endpoint reached at termination of test.
5. Failure imminent - test terminated.
6. Joist failure - 11.5 min., flame thru - 13.0 min., collapse - 24 min.
7. Joist failure - 17 min., flame thru - 18 min., collapse - 33 min.
8. Joist failure - 18 min., flame thru - 8 min., collapse - 30 min.
9. Joist failure - 12 min., flame thru - 8 min., collapse - 22 min.
10. Joist failure - 11 min., flame thru - 17 min., collapse - 27 min.
11. Joist failure - 17 min., flame thru - 20 min., collapse - 43 min.
12. Joists: 2"x 10" southern pine or douglas fir; No.1 common or better; Subfloor: 3/4" wood sheathing diaphram of asbestos paper, and finish of tongue and grove wood flooring.
13. Loadings: not more than 1,000 PSI maximum fiber stress in joists.
14. Perforations in gypsum lath are to be not less than 3/4" diameter with one perforation for not more than 16/in^2 diameter.

FIGURE 3.4

FLOOR/CEILING ASSEMBLIES

Hollow Clay Tile With Reinforced Concrete

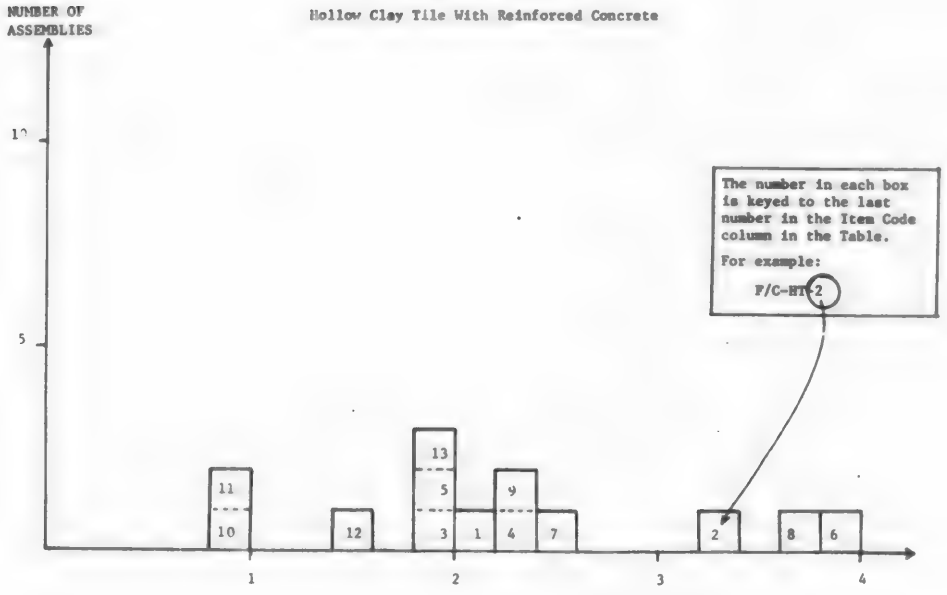


TABLE 3.4

FLOOR/CEILING ASSEMBLIES

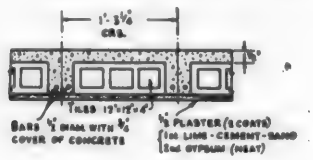
Hollow Clay Tile with Reinforced Concrete

Item Code	Assembly Thickness	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
F/C-HT-1	6"	Cover 1½" concrete (6080 PSI); 3 cell hollow clay tile; 12"x 12"x 4"; 3½" concrete between tiles including 2- ½" rebars with 3/4" concrete cover; ½" plaster cover (lower)	75 PSF	2 hr. 7 min.			7	1,2,3	2
F/C-HT-2	6"	Cover 1½" concrete (5840 PSI); 3 cells hollow clay tiles; 12"x 12"x 4"; 3½" concrete between tile including 2- ½" rebars each with ½" concrete cover and 5/8" filler tiles between hollow tiles; ½" plaster cover, lower.	61 PSF	3 hr. 23min.			7	3,4,6	3-1/3
F/C-HT-3	6"	Cover: 1½" concrete (6280 PSI); 3 cell hollow clay tiles 12"x 12"x 4"; 3½" concrete between tiles including 2- ½" rebars with ½" cover; ½" plaster cover, lower.	122 PSF	2 hr.			7	1,3,5, 8	2
F/C-HT-4	6"	Cover: 1½" concrete (6280 PSI); 3 cell hollow clay tiles; 12" x 12"x 4"; 3½" concrete between tiles including 2- ½" rebars with 3/4" concrete cover; ½" plaster cover, lower.	115 PSF	2 hr. 23min.			7	1,3,7	2-1/3
F/C-HT-5	6"	Cover: 1½" concrete (6470 PSI); 3 cell hollow clay tiles 12"x 12"x 4"; 3½" concrete between tiles including 2- ½" rebars with ½" cover; ½" plaster cover, lower.	122 PSF	2 hr.			7	1,3,5, 8	2
F/C-HT-6	8"	Floor cover: 1½" gravel cement (4300 PSI); tiles: 3 cell 12"x 12"x 6"; 3½" space between tiles including 2- ½" rebars with 1" cover from concrete bottom ; cover: ½" plaster, lower	165 PSF	4 hr.			7	1,3,9, 10	4
F/C-HT-7	9"(nom)	Deck: 7/8" T & G on 2"x 1½" bottoms (18" O.C.) 1½" concrete cover (4600 PSI); 3 cell hollow clay tiles 12"x 12"x 4"; 3" concrete between tiles including 1- 3/4" rebar 3/4" from tile bottom ; ½" plaster cover.	95 PSF	2 hr. 26min.			7	4,11, 12,13	2-1/3
F/C-HT-8	9"(nom)	Deck: 7/8" T&G on 2"x 1½" bottoms (18" O.C.) 1½" concrete cover with 3850 PSI; 3 cell hollow clay tiles 12"x 12"x 4"; 3" concrete between tiles including 1- 3/4" rebar 3/4" from tile bottoms; ½" plaster cover.	95 PSF	3 hr. 28min.			7	4,11, 12,13	
F/C-HT-9	9"(nom)	Deck: 7/8" T&G on 2"x 1½" bottoms (18"O.C.) 1½" concrete cover (4200 PSI); 3 cell hollow clay tiles 12"x 12"x 4"; 3" concrete between tiles including 1- 3/4" rebar 3/4" from tile bottoms; ½" plaster cover.	95 PSF	2 hr. 14min.			7	3,5,8 11	
F/C-HT-10	5½"	Fire clay tile (4" thick); 1½" concrete cover. For general details see note 15.	See Note 14	1 hr.			43	15	1
F/C-HT-11	8"	Fire clay tile (6" thick); 2" cover.	See Note 14	1 hr.			43	15	1
F/C-HT-12	5½"	Fire clay tile (4" thick); 1½" cover. 5/8" gypsum plaster lower.	See Note 14	1½ hr			43	15	1½
F/C-HT-13	8"	Fire clay tile (6" thick); 2" cover. 5/8" gypsum plaster lower.	See Note 14	2 hr.			43	15	1½

TABLE 3.4

NOTES

1. A generalized cross-section of this floor type follows.



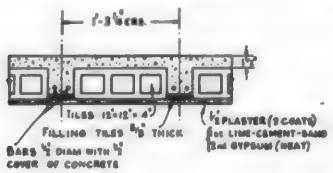
2. Failure mode - structural.

3. Plaster - base coat - lime - cement - sand; top coat - gypsum (neat).

4. Failure mode - collapse.

5. Test stopped before any end points were reached.

6. A generalized cross-section of this floor type follows.



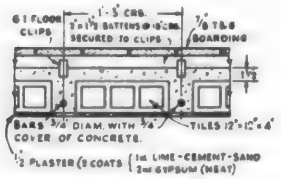
7. Failure mode - thermal -back face temperature rise.

8. Passed hose stream test.

9. Failed hose stream test.

10. Test stopped at 4 hours before any end points were reached.

11. A generalized cross-section of this floor type follows.



12. Plaster-base coat - retarded hemihydrate gypsum-sand; 2nd coat - neat gypsum.

13. Concrete in item 7 is P.C. based but with crushed brick aggregates while in item 8 river sand and river gravels are used with the P.C.

14. Load - unspecified.

15. The 12" x 12" fire-clay tiles were laid end to end in rows spaced 2½" or 4" apart. The reinforcing steel was placed between these rows and the concrete cast around them and over the tile to form the structural floor.

TABLE 3.5

FLOOR/CEILING ASSEMBLIES

STEEL STRUCTURAL ELEMENTS (1)

NON-STANDARD NBS TESTS FOR FIRE ABOVE FLOOR

Item Code	(2) Minimum Dimension	Construction Details	Performance		Reference Number			Notes	(3) Recc. Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
F/C-S-1a	¼"	4" deep - 7.7 lb. I beams; ¼" bare plate floor cont. welded seams.	105 PSF	35 min			6		½
F/C-S-2a	¼"	4" deep - 7.7 lb. I beams; ¼" bare plate floor cont. welded seams.	72 PSF	43 min			6		2/3
F/C-S-3a	3/16"	4" deep - 7.7 lb. I beams; ¼" plate floor with 3/16" linoleum.	105 PSF	1 hr 3 min.			6		1
F/C-S-4a	½"	5" deep - 10 lb. I beams; plate floor with ½" asphalt emulsion concrete.	165 PSF	1 hr. 21 min			6		1-1/3
F/C-S-5a	2"	13' span - 4" deep 7.7 lb. I beams on 4" deep 7.7 lb. I beam girder; ¼" plate floor with 2" concrete.	203 PSF	1 hr. 40 min			6		1-2/3
F/C-S-6a	2"	13' span - 4" deep 7.7 lb. I beams on 4: deep 7.7 lb. I beam girder; ¼" plate floor with 2" concrete topping.	184 PSF.	3 hrs.			6		3

TABLE 3.5

NOTES

1. These results are based on a series of non-standard burnout tests with fire located above the floor being tested. Time - temperature histories were used to develop a time figure equivalent to a standard fire test exposure of the duration listed. All floors included ¼" steel plate, 18 feet long with supporting beams 24" O.C. The specimen was 13½ feet wide.

2. Thickness of upper floor layer.

3. Results apply for an expected fire above floor only.

SECTION IV

BEAMS

TABLE 4.1.1

REINFORCED CONCRETE BEAMS

Depth - 10" to Less Than 12"

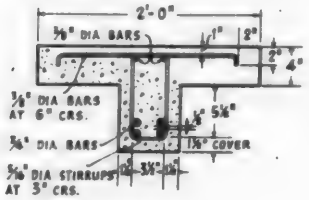
Item Code	Depth	Construction Details	Performance		Reference Number			Notes	Rec. Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
B-10-RC-1	10"	24" wide x 10" deep reinforced concrete "T" beam (3290 PSI); Details - See figure, Note 5.	8.8 tons	4 hr. 2 min.			7	1,2	4
B-10-RC-2	10"	24" wide x 10" deep reinforced concrete "T" beam (4370 PSI); Details - See figure, Note 6.	8.8 tons	1 hr. 53 min			7	1,3	1-3/4
B-10-RC-3	10½"	24" wide x 10-1/2" deep reinforced "T" beam (4450 PSI) concrete; Details - See figure, Note 7.	8.8 tons	2 hr 40 min			7	1,3	2-2/3
B-11-RC-4	11"	24" wide x 11" deep reinforced concrete "T" beam (2400 PSI); Details - See figure, Note 8.	8.8 tons	3 hr 32 min			7	1,3	3-1/2
B-11-RC-5	11"	24" wide x 11" deep reinforced concrete "T" beam (4250 PSI); Details - See figure, Note 9.	8.8 tons	3 hr 3 min			7	1,3	3
B-11-RC-6	11"	Concrete flange: 4" deep x 2' wide (4895 PSI) concrete; 7" deep 6½ wide beam; I beam reinforcement: 10" x 4½" x 25 lb. R.S.J.; 1" cover on flanges; Rein.: 3/8" diam. bars @ 6" pitch parallel to T; ½" diam. bars perpendicular to T; 4" x 6" wire mesh #13 SWG; Span - 11' restrained. Details - See figure, Note 10.	10 tons	6 hr			7	1,4	6
B-11-RC-7	11"	Concrete flange: 6" deep x 1'6½" wide (3525 PSI) concrete; 5" deep x 8" wide precast concrete blocks 8-3/4" long; I beam reinforcement: 7" x 4" x 16 lb. R.S.J. 2" cover on bottom; 1½" cover on top; 2 rows ½" diam. rods parallel to T; 1/8" wire mesh perpendicular to 1" span 1'3" simply supported. Details - See figure, Note 11.	3.9 tons	4 hr			7	1,2	4
B-11-RC-8	11"	Concrete flange: 4" x 2' (3525 PSI) concrete; 7" x 4½" (scaled fr. drawing) I beam reinforcement: 10" x 4½" x 25 lb. R.S.J.; No concrete cover on bottom. Rein.: 3/8" diam. bars @ 6" pitch parallel to T; ½" diam. bars perpendicular to T; span: 11" restricted	10 tons	4 hr			7	1,2	4
B-11-RC-9	11½"	24" wide x 11½" deep reinforced concrete "T" beam (4390 PSI_; Details - See figure, Note 12.	8.8 tons	3 hr 24 min			7	1,3	3-1/3

TABLE 4.1.1

NOTES

1. Load concentrated at mid-span.
2. Achieved 4 hour performance (Class-B, British)
3. Failure mode - collapse.
4. Achieved 6 hour performance (Class-A, British)

5.



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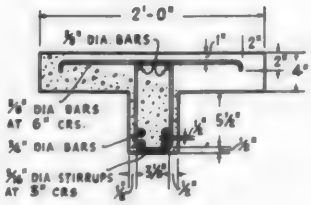

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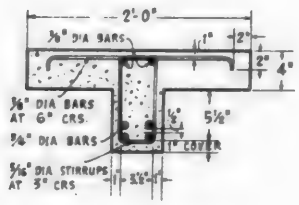

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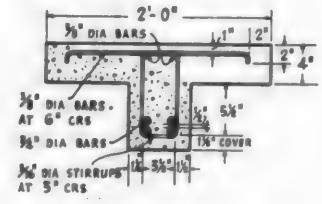

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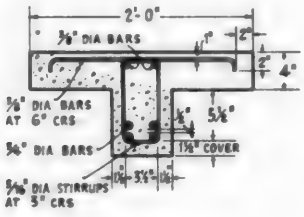

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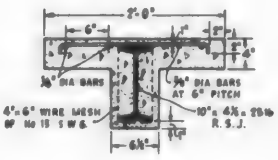

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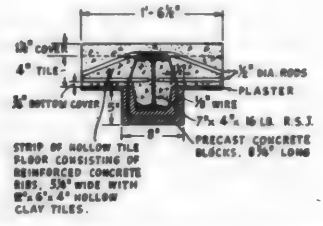
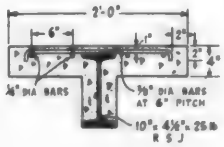

1'-6¾"
½" COVER
4" TILE
⅜" DIA RODS
PLASTER
⅜" BOTTOM COVER
⅛" WIRE
7½"× 4"× 16 LB. R.S.J.
PRECAST CONCRETE BLOCKS. 8¾" LONG
STRIP OF HOLLOW TILE FLOOR CONSISTING OF REINFORCED CONCRETE RIBS, 5⅜" WIDE WITH 12"× 6"× 4" HOLLOW CLAY TILES.

Span and End Conditions :—10'—3" (Clear). Simply Supported.

12.



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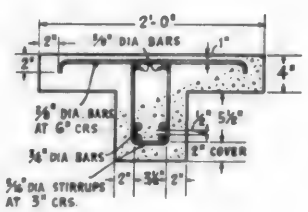


TABLE 4.1.2

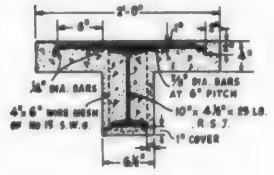
REINFORCED CONCRETE BEAMS

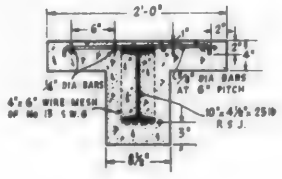
Depth - 12" to Less Than 14"

Item Code	Depth	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
B-12-RC-1	12"	12"x 8" section; 4160 PSI aggregate concrete; Reinforcing 4- 7/8" rebars at corners; 1" below each surface; ¼" stirrups 10" O.C.	5.5 tons	2 hr.			7	1	2
B-12-RC-2	12"	Concrete flange: 4" deep x 2' wide (3065 PSI) @ 35 days; Concrete beam: 8" deep; I beam reinforcement: 10"x 4⅛"x 25 lb. R.S.J.; 1" cover on flanges; Reinforcement: Flange 3/8" diam. bars @ 6" pitch parallel to T; flange ¼" diam. bars perpendicular to T; beam 4"x 6" wire mesh #13 S.W.G.; Span: 10'3" simply supported.	10 tons	4 hr.			7	2,3 5	4
B-13-RC-3	13"	Concrete flange: 4" deep x 2' wide; (3825 PSI) @ 46 days; Concrete beam: 9" deep x 8½" wide; (scaled from dwg.); I beam reinforcement: 10"x 4⅛"x 25 lb. R.S.J.; 3" cover on bottom flange 1" cover on top flange; Reinforcement: flange 3/8" diam. bars @ 6" pitch, parallel to T; ¼" diam. bars perpendicular to T; Beam 4"x 6" wire mesh #13 S.W.G.; Span 11' restrained.	10 tons	6 hr.			7	2,3 6	6
B-12-RC-4	12"	Concrete flange: 4" deep x 2' wide; (3720 PSI) @ 42 days; Con. beam: 8" deep x 8½" wide; (scaled fr. dwg.) I beam reinforcement: 10"x 4⅛"x 25 lb. R.S.J.; 2" cover bottom flange; 1" cover top flange: Reinforcement: flange 3/8" diam. bars @ 6" pitch parallel to T; ¼" diam. bars perpendicular to T; beam; 4"x 6" wire mesh, #13 S.W.G.; Span: 11' restrained.	10 tons	6 hr.			7	2,3,4 7	6

TABLE 4.1.2

NOTES

1. Qualified for 2 hr. use. (Grade C - British) test included hose stream and reload at 48 hours.
2. Load concentrated at mid-span.
3. British test.
4. British test - qualified for 6 hour use (Grade A).
5. 

6. 

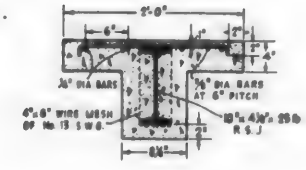
7. 

TABLE 4.1.3

REINFORCED CONCRETE BEAMS

Depth - 14" to Less Than 16"

Item Code	Depth	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
B-15-RC-1	15"	Concrete Flange: 4" Deep x 2' wide; (3290 PSI) concrete; Concrete beam: 10" deep x 8½" wide; I beam reinforcement: 10"x 4⅝"x 25 lb. R.S.J.; 4" cover on bottom flange; 1" cover on top flange; Reinforcement: Flange ; 3/8" diam. bars @ 6" pitch parallel to T; ½" dia. bars perpendicular to T; beam 4"x 6" wire mesh No. 13 S.W.G.; Span: 11' restrained.	10 tons	6 hr.			7	1,2 3	6
B-14-RC-2	14"	Concrete flange: 4" deep x 2' wide (4820 PSI) concrete; Concrete beam: 10" deep x 8½" wide; I beam reinforcement: 10"x 4⅝" x 25 lb. R.S.J. 1" cover on flanges; Reinforcement: Flange 3/8" diam. bars @ 6" pitch parallel to "T"; ½" diam bars perpendicular to "T"; beam 4"x 6" wire mesh No. 13 S.W.G.; Span: 11' restrained.	10 tons	6 hr.			7	1,2 4	6

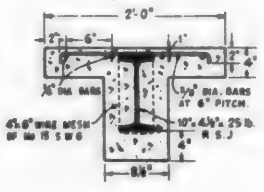
TABLE 4.1.3

NOTES

1. Load concentrated at mid-span.

2. Achieved 6 hour fire rating (Class "A" - British).

3.



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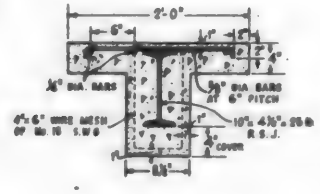

TABLE 4.2.1

STEEL BEAMS - UNPROTECTED

Depth - 10" to Less Than 12"

Item Code	Depth	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS-92	Post-BMS-92		
B-SU-1	10"	10"x 4½"x 25 lb. "I" beam.	10 tons	39min.			7	1	1/3

TABLE 4.2.1

NOTES

1. Concentrated at midspan.

TABLE 4.2.2

STEEL BEAMS - CONCRETE PROTECTION

Depth 10" to Less Than 12"

Item Code	Depth	Construction Details	Performance		Reference Number			Notes	Rec Hours
			Load	Time	Pre-BMS-92	BMS -92	Post-BMS-92		
B-SC-1	10"	10"x 8" rectangle. Aggregate concrete (4170 PSI) with 1" cover - top and 2" cover bottom; No. 13 S.W.G. iron wire loosely wrapped at approximately 6" pitch about 7"x 4"x 16 lb. I beam.	3.9 tons	3 hr. 46min			7	1,2,3	3-3/4
B-SC-2	10"	10"x 8" rectangle. Aggregate concrete (3630 PSI) with 1" cover - Top and 2" cover bottom; No. 13 S.W.G. iron wire loosely wrapped at approx. 6" pitch about 7"x 4"x 16 lb. I beam.	5.5 tons	5 hr. 26min			7	1,4,5	

TABLE 4.2.2

NOTES

1. Load concentrated at midspan.
2. Specimen 10'3" clear span simply supported.
3. Passed grade "C" fire resistance (British) including hose stream and reload.
4. Specimen 11' clear span - restrained.
5. Passed "Grade B" fire resistance (British) including hose stream and reload.

SECTION V

DOORS AND DOOR MATERIALS

FIGURE 5.1

RESISTANCE OF DOORS TO FIRE EXPOSURE

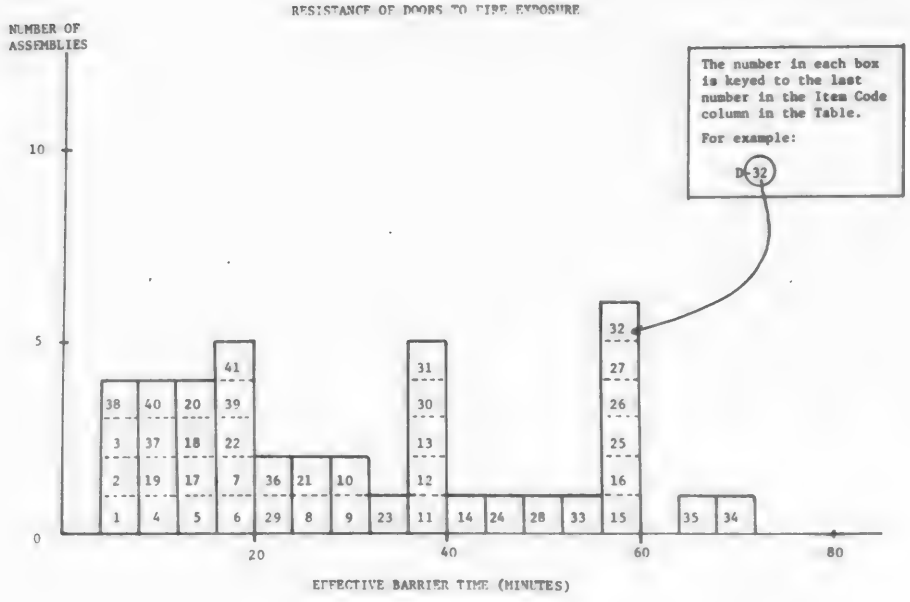
NUMBER OF ASSEMBLIES
10
5
0
20
40
60
80
EFFECTIVE BARRIER TIME (MINUTES)
The number in each box is keyed to the last number in the Item Code column in the Table.
For example:
D-32
1 4 5 6 29 8 9 23 11 14 24 28 33 15 35 34
2 19 17 7 36 21 10 12 16
3 37 18 22 25
38 40 20 39 26
41 27
31 30 13
32

TABLE 5.1

RESISTANCE OF DOORS TO FIRE EXPOSURE (12)

Item Code	Door Minimum Thickness	Construction Details	Performance: Effective Barrier	Performance: Edge Flaming	Reference Number: Pre-BMS-92	Reference Number: BMS-92	Reference Number: Post-BMS-92	Notes	Rec (min.)
D-1	3/8"	Panel door, pine perimeter (1-3/8"). Painted (enamel).	5 min. 10 sec.	n/a			90	1,2	5
D-2	3/8"	As above, with 2 coats U.L. listed intumescent coating.	5 min. 30 sec	5 min			90	1,2,7	5
D-3	3/8"	As D-1 with standard primer and flat interior paint.	5 min. 55 sec	n/a			90	1,3,4	5
D-4	2-5/8"	As D-1 with panels covered each side with ½" plywood, edge grouted with sawdust filled plaster; door faced with 1/8" hardboard each side; paint see (5)	11 min 15 sec	3 min 45sec			90	1,2,5, 7	10
D-5	3/8"	As D-1 but surface protected with glass fiber reinforced intumescent fire retardant coating.	16 min.	n/a			90	1,3,4 7	15
D-6	1-5/8"	Door detail: As D-4 but with 1/8" cement asbestos board facings with aluminum foil. Door edges protected by sheet metal.	17 min.	10min. 15sec.			90	1,3,4	15
D-7	1-5/8"	Door detail with 1/8" hardboard cover each side as facings. Glass fiber reinforced intumescent coating applied.	20 min.	n/a			90	1,3,4 7	20
D-8	1-5/8"	Door detail as D-4. Paint was glass reinforced Epoxy intumescent.	26 min.	24min. 45sec.			90	1,3,4 6,7	25

5.1 (cont'd)

RESISTANCE OF DOORS TO FIRE EXPOSURE

Item Code	Door Minimum Thickness	Construction Details	Performance		Reference Number		Notes	Rec (min.)
			Effective Barrier	Edge Flaming	Pre-RMS-92	Post-RMS-92		
D-9	1-5/8"	Door detail as D-4 with facings of 1/8" cement asbestos board.	29 min. 15sec	3min		90	1,2	5
D-10	1-5/8"	As per D-9.	31min. 30sec.	7min. 20sec.		90	1,3,4	6
D-11	1-5/8"	As per D-7 painted with epoxy intumescent coating including glass fiber roving.	36min. 25sec.	n/a		90	1,3,4	35
D-12	1-5/8"	As per D-4 with intumescent fire retardant paint.	37min. 30sec.	24min 40sec		90	1,3,4	30
D-13	1¾ (nom)	As per D-4 but with 24 ga. galv. sheet metal facings.	39min.	39min.		90	1,3,4	39
D-14	1-5/8"	As per D-9.	41min. 30sec.	17min 20sec		90	1,3,4 6	20
D-15	--	Class C steel fire door.	60min.	58min.		90	7,8	60
D-16	--	Class B steel fire door.	50min.	57min.		90	7,8	60
D-17	1-3/4"	Solid core flush door; core staves laminated to facings but not each other. Birch plywood facings ½" rebate in door frame for door; 3/32" clearance between door and wood frame.	15min.	13min		37	11	13
D-18	1-3/4"	As per D-17	14min.	13min		37	11	13
D-19	1-3/4"	Door as per D-17; but with 16 ga. steel; 3/32" door frame clearance.	12min.	--		37	9,11	10
D-20	1-3/4	As per D-19.	16min.	--		37	10,11	10
D-21	1-3/4"	Door as per D-17 intumescent paint applied to top and side edges.	26min.	--		37	11	25
D-22	1-3/4"	Door as per D-17 but with ½"x1/8" steel strip set into edges of door at top and side facing stops. Matching strip on stop.	18min.	6min		37	11	18
D-23	1-3/4"	Solid Oak Door	36min.	22min.		15	13	25
D-24	1-7/8"	Solid Oak Door	45min.	35min		15	13	35
D-25	1-7/8"	Solid Teak Door	58min.	34min.		15	13	35
D-26	1-7/8"	Solid (Pitch) Pine Door	57min.	36min.		15	13	35
D-27	1-7/8"	Solid Deal (Pine) Door	57min.	30min.		15	13	30
D-28	1-7/8"	Solid Mahogany Door	49min.	40min.		15	13	45
D-29	1-7/8"	Solid Poplar Door	24min.	3min.		15	13,14	5
D-30	1-7/8"	Solid Oak Door	40min.	33min.		15	13	35
D-31	1-7/8"	Solid Walnut Door	40min.	15min.		15	13	20
D-32	2-5/8"	Solid Quebec Pine	60min	60min.		15	13	60
D-33	2-5/8"	Solid Pine Door	55min.	39min.		15	13	40

5.1 (cont'd)

RESISTANCE OF DOORS TO FIRE EXPOSURE

Item Code	Door Minimum Thickness	Construction Details	Performance Effective Edge Barrier	Performance Flaming	Reference Number Pre-HMS-92	Reference Number Post-HMS-92	Notes	Rec (min.)
D-34	2-5/8"	Solid Oak Door	69 min	60min		15	13	60
D-35	2-5/8"	Solid Teak Door	65 min	17min		15	13	60
D-36	1¾"	Solid Softwood Door	23 min	8½min		15	13	10
D-37	3/4"	Panel Door	8 min	7½min		15	13	5
D-38	5/16"	Panel Door	5 min	5 min		15	13	5
D-39	3/4"	Panel Door - Fire Retardant Treated	17½min	13min		15	13	8
D-40	3/4"	Panel Door - Fire Retardant Treated	8½min	8½min		15	13	8
D-41	3/4"	Panel Door - Fire Retardant Treated	16-3/4 min.	11½ min.		15	13	8

TABLE 5.1

NOTES

1. All door frames were of standard lumber construction.
2. Wood door stop protected by asbestos millboard.
3. Wood door stop protected by sheet metal.
4. Door frame protected with sheet metal and weather strip.
5. Surface painted with intumescent coating.
6. Door edge sheet metal protected.
7. Door edge intumescent paint protected.
8. Formal steel frame and door stop.
9. Door opened into furnace at 12'.
10. Similar door opened into furnace at 12'.
11. The doors reported in these tests represent the type contemporaries used as 20 minute solid core wood doors. The test results demonstrate the necessity of having wall anchored metal frames, minimum clearers possible between door, frame and stops. They also indicate the utility of long throw latches and the possible use of intumescent paints to seal doors to frames in event of a fire.
12. Minimum working clearance and good latch closure are absolute necessities for effective containment for all such working door assemblies.
13. Based on British Tests.
14. Failure at door - frame interface.

FIGURE 5.2

RESISTANCE OF DOOR MATERIALS OF VARIOUS THICKNESS TO FIRE PENETRATION

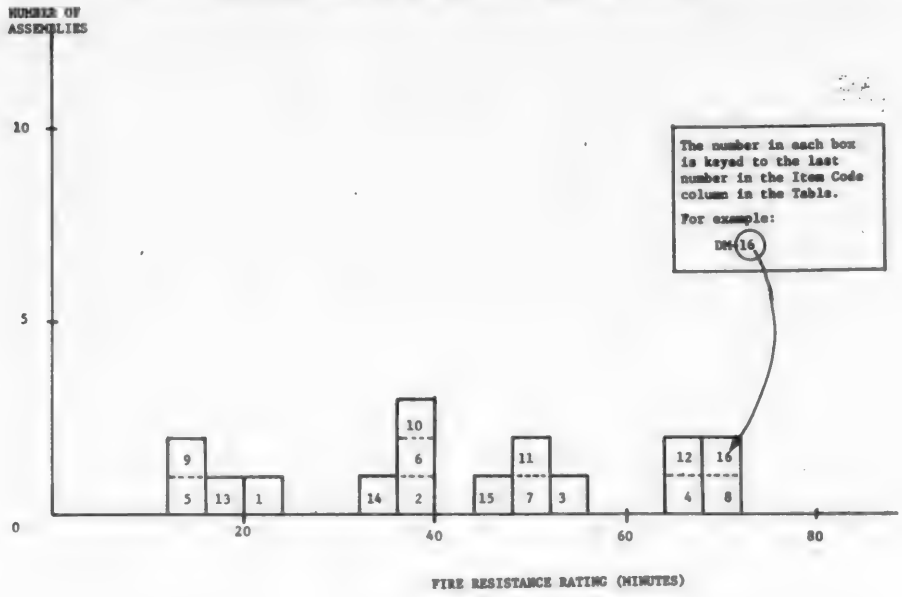

TABLE 5.2

RESISTANCE OF DOOR MATERIALS

OF VARIOUS THICKNESS TO FIRE PENETRATION (1)

Item Code	Thickness	Construction Details	Performance	Reference Number			Notes	Rec (min.)
			Flame thru (min.)	Pre-BMS-92	BMS-92	Post-BMS-92		
DM-1	½"	Teak	21			15		20
DM-2	1"	Teak	39½			15		35
DM-3	1½"	Teak	53½			15		50
DM-4	2"	Teak	68			15		65
DM-5	½"	Spruce	16			15		15
DM-6	1"	Spruce	37			15		35
DM-7	1½"	Spruce	49½			15		45
DM-8	2"	Spruce	70			15		70
DM-9	½"	"Baltic Redwood" (a pine wood)	13½			15		10
DM-10	1"	"Baltic Redwood" (a pine wood)	36½			15		35
DM-11	1½"	"Baltic Redwood" (a pine wood)	47			15		45
DM-12	2"	"Baltic Redwood" (a pine wood)	65½			15		65
DM-13	½"	Baltic Redwood (a pine wood) treated with a water soluble fire retardant salt solution.	16½			15		15

5.2 (cont'd)

RESISTANCE OF DOOR MATERIALS OF VARIOUS THICKNESS TO FIRE PENETRATION

Item Code	Thickness	Construction Details	Performance	Reference Number			Notes	Rec (min.)
			Flame thru (min.)	Pre-HMS-92	HMS -92	Post-HMS-92		
DM-14	1"	Baltic Redwood (a pine wood) treated with a water soluble fire retardant salt solution.	32½			15		30
DM-15	1½"	Baltic Redwood (a pine wood) treated with a water soluble fire retardant salt solution.	45			15		45
DM-16	2"	Baltic Redwood (a pine wood) treated with a water soluble fire retardant salt solution.	69			15		65

TABLE 5.2

NOTES

1. These are guideline figures only for such solid wood materials. Workmanship, harware condition and good door closure must exist. It is also advised that an intumescent coating be applied to door edges (top and sides) and stop surfaces contacting door if such figures are to be applied as indicated.

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